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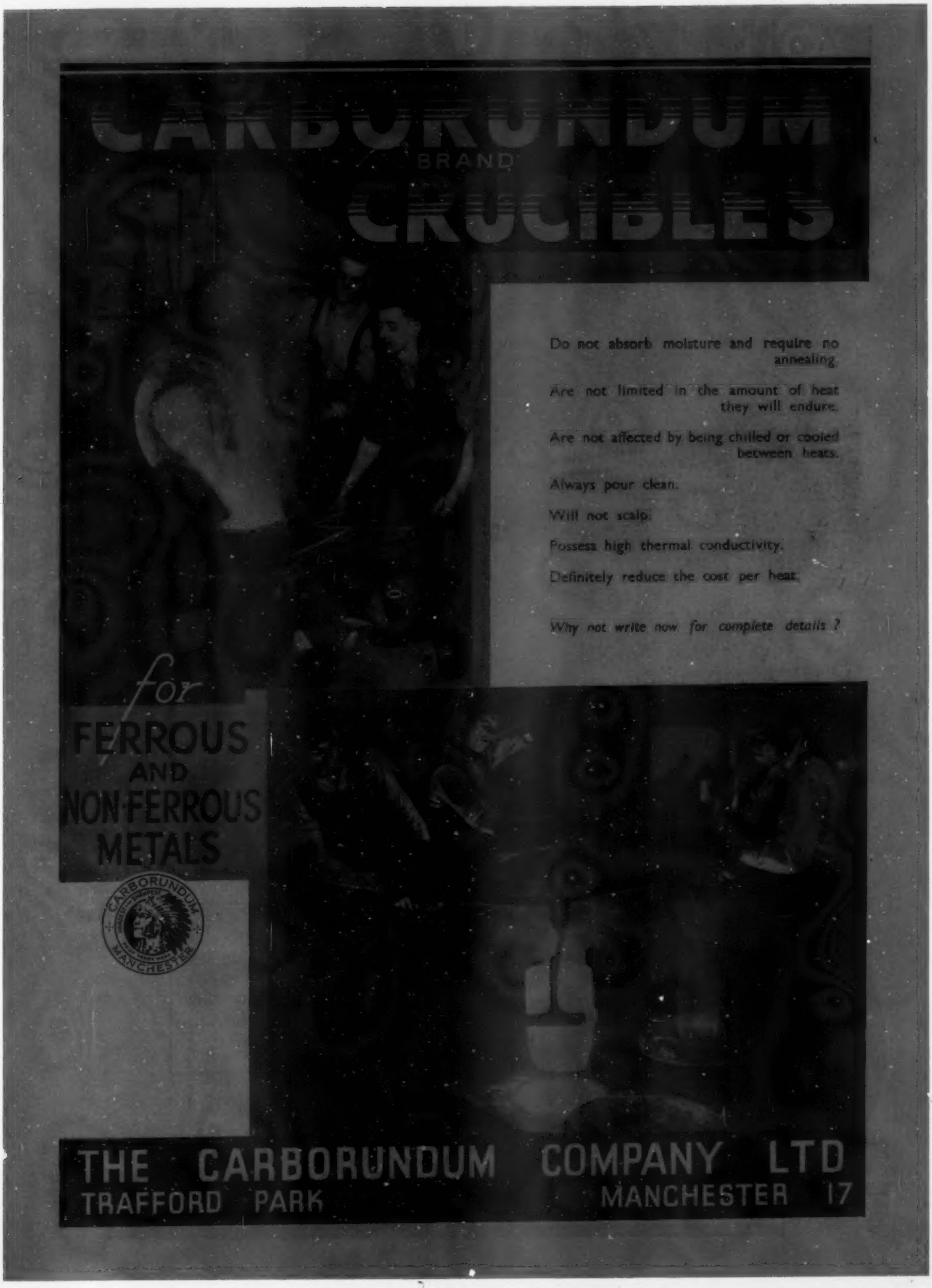
METALLURGIA

THE BRITISH JOURNAL OF METALS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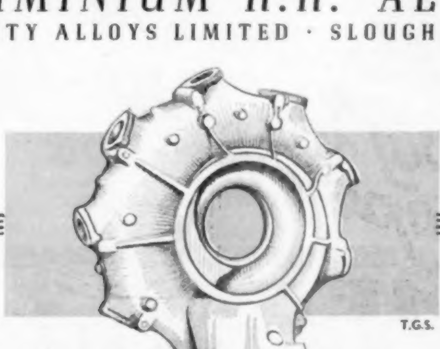

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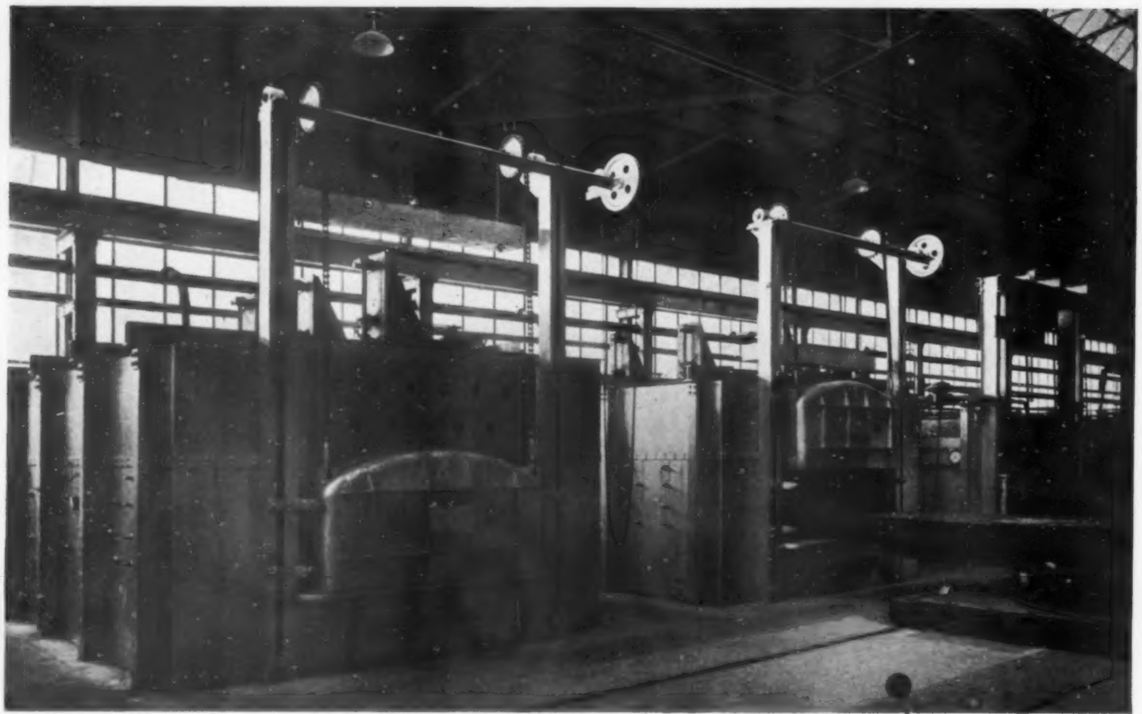

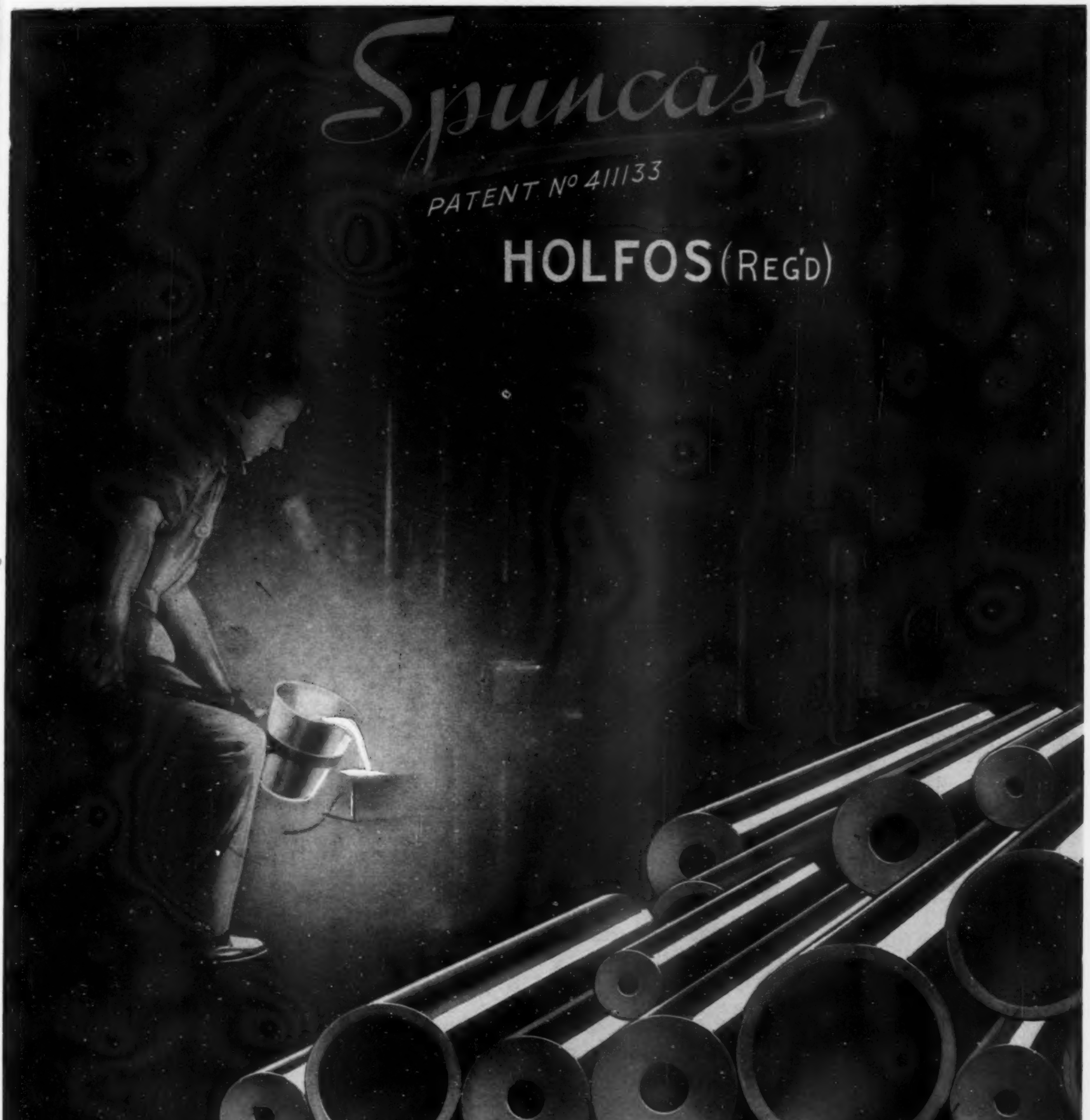
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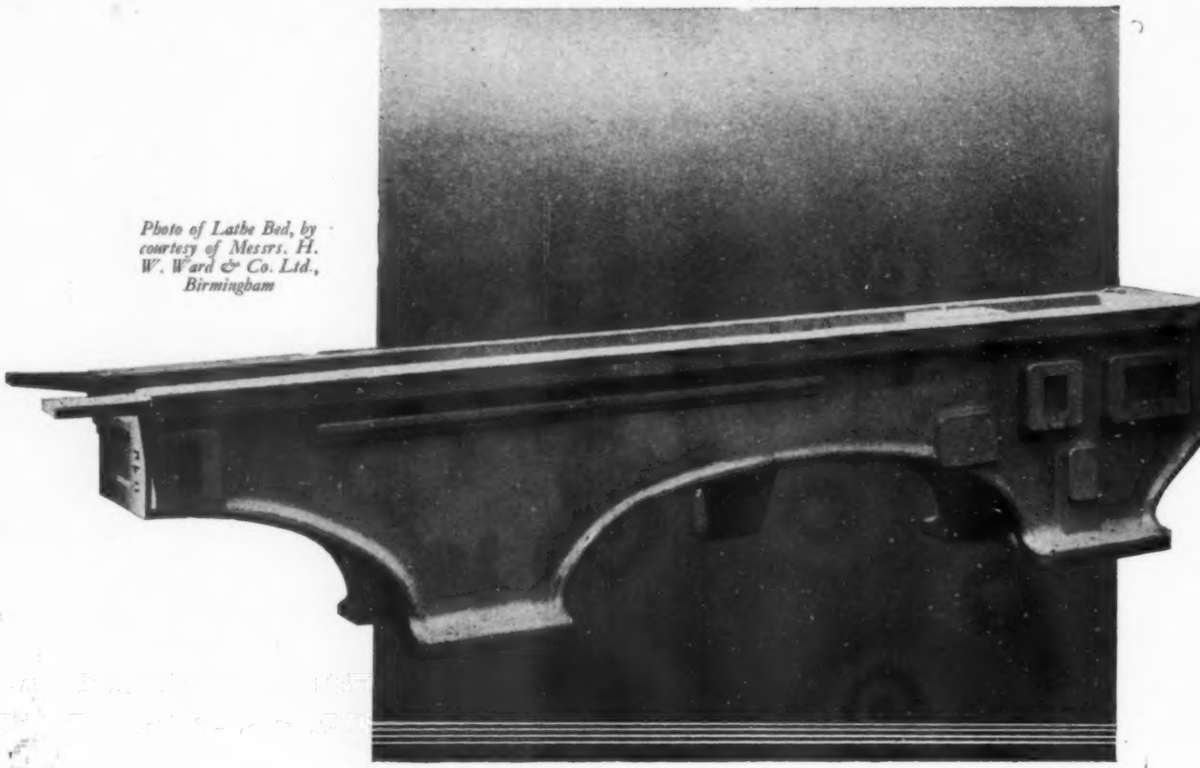

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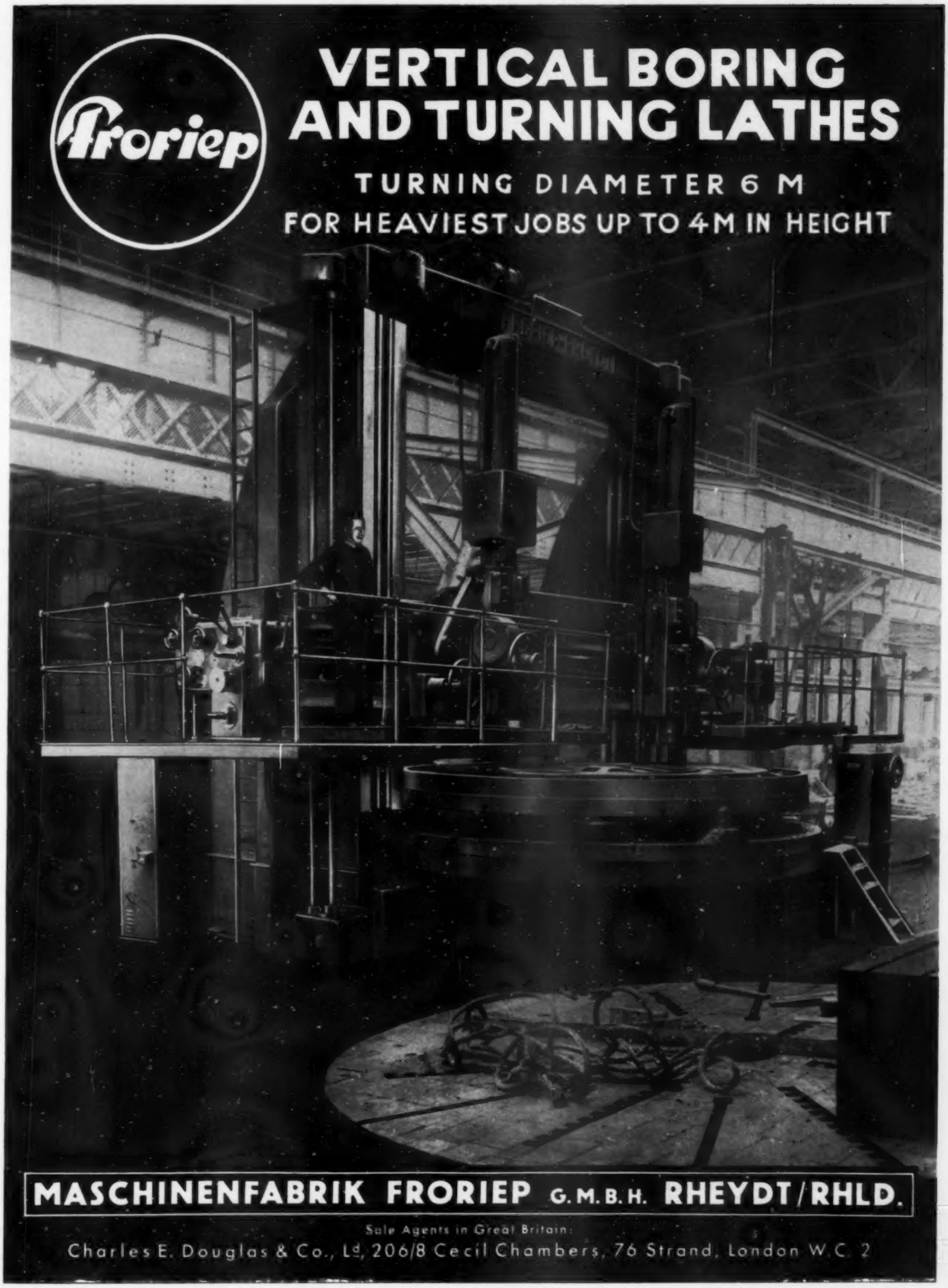
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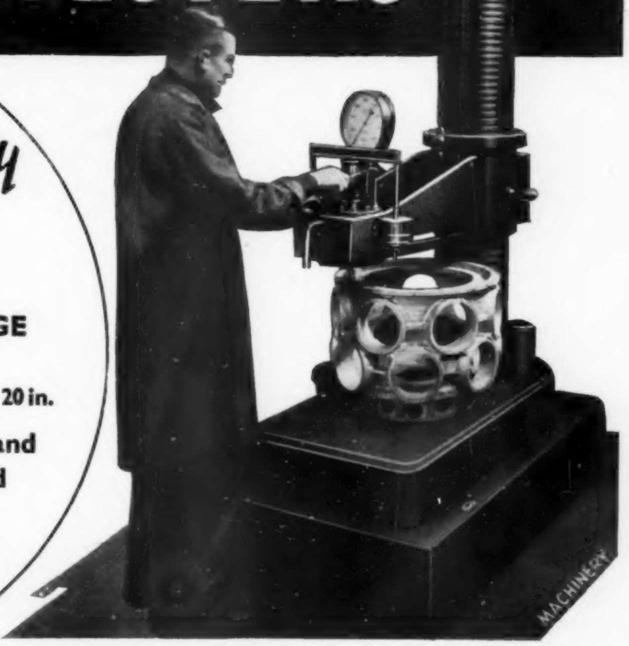

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METALLURGIA

The British Journal of Metals
(INCORPORATING THE METALLURGICAL ENGINEER.)

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To Our Readers

Postponement of Tour

On the point of dispatching this issue of METALLURGIA we have been advised of the postponement of the tour to Canada and the United States and the cancellation of the Joint Meetings of the British Institutes with the corresponding American Institutes in New York.

In view of the present serious political situation it is felt that key-men engaged in the ferrous and non-ferrous industries should remain at home until conditions become more settled, but it is hoped that Joint Meetings in New York, with such possibilities as they present, will be possible next year.

This issue shows something of the facilities which the programme provided and details, at length, some of the outstanding features of Canada and the United States which many readers had hoped to see, and, although the visit has been postponed, we believe it will be read with great interest.

THE EDITOR.

METALLURGIA,
Kennedy Press Ltd.,
Manchester.

Sept. 16th, 1938.

METALLURGIA
THE BRITISH JOURNAL OF METALS.
INCORPORATING "THE METALLURGICAL ENGINEER"

Institutes' Joint Meetings in America

THE world is still full of wars and rumours of wars, yet it is the most disastrous force retarding progress and the experiences of the Great War brought home to us that all questions of peace and war are of common interest to every country. But, in the spate of words which seem, at the time of writing, to be inspiring hatred and giving cause for the war rumours, there is some comfort in the thought that the premier British technical societies in the ferrous and non-ferrous fields are visiting the United States of America, on the invitation of corresponding societies in that country, to hold their autumn meetings. These meetings, which have for their object the development of knowledge, whether scientific or technical, are especially important when held abroad. More than anything, they bring about friendly discussion of problems which are common to all industrial countries. Quite apart from the mutual advantages to be gained from discussions of this character, the good feeling engendered is probably of more vital importance, for it tends to promote good will.

This joint meeting of the British Iron and Steel Institute and Institute of Metals with the American Iron and Steel Institute and American Institute of Mining and Metallurgical Engineers is exceptional in that it is a meeting of the representative Institutes of the English-speaking nations, and each of the British members and guests attending the meeting will carry a message of good will from the people of this country, and show how much there is in common between the peoples of the two countries. The personal contact possible, as a result of the many visits arranged, will do more to cement the friendship which already exists than written communications can possibly do.

Although the technical meetings will be held in the United States the visit includes Canada. Both these countries were essentially agricultural countries, but each is rich in mineral resources which have resulted in rapid industrial development. The mineral resources of the United States are probably greater in proportion to size than those of any other country, but little attempt was made to develop them until the end of the first half of the 19th century. Since then, however, the rapid development has placed that country ahead of other countries in this respect. The most widely distributed mineral is coal, most of which is bituminous—anthracite is found in only one or two districts. Next in importance comes iron, which is very widely distributed. In iron-mining the use of machinery is intensive, and it is doubtful whether there is so little hand labour elsewhere. In Lake Superior district and others, copper has been mined in immense quantities. In addition, America is the greatest producer of lead, and zinc is also produced in large quantities ; mercury and aluminium-bearing ores are also profitably mined. The mineral products include gold and silver and practically all known metals. The country is also one of the world's chief petroleum producers, while another valuable product is natural gas ; its mineral deposits make it one of the richest of countries.

The extension of Canada's metal industries has been the outstanding development in recent years in her economic situation, and the progress has not been alone in physical development, as visitors will see, but has included important improvements in metallurgical practice. Canada is enjoying a state of industrial recovery largely due to the revival in demand for those products she is able to supply from her great natural resources. Probably the most outstanding feature is the remarkable expansion of her gold-mining industry, but base-metal production has developed very rapidly.

The programme arranged for this visit is very comprehensive, and for the benefit of those of our readers who are unable for various reasons to attend the meeting, an effort has been made to present in this issue a summary of the programme, together with a brief description of some of the plants to be visited and the districts in which they are situated. Many of the plants are so large that each would need more than one issue for a complete description ; in some instances, therefore, attention has been directed to a particular part of a plant that has a special interest rather than to condense a description beyond useful limits. Every effort has been made to ensure the accuracy of the information given and to support it adequately by suitable illustrations. So many works are included in the programme that it would be almost impossible to give information about each, however brief the description, but it is thought that the representative selection given will prove interesting and informative. By courtesy of the Presidents of the various Institutes concerned, we publish messages from them in the form of a Foreword.

So comprehensive are the arrangements that those attending the meeting may have little opportunity to study some of the outstanding features of the United States apart from its ferrous and non-ferrous industries. The buildings, of course, are of an outstanding character, from the point of view of size, but this bigness complex is characteristic of the Americans : consider the measures Mr. Roosevelt is trying to complete—what he refers to as social security for our people. These measures are colossal. His emergency measures for the unemployed, for instance, resulted in the largest system of relief works that the world has ever known. At the peak, his Works Progress Administration created jobs for about three million unemployed people, and paid them good wages. There are still over two million so engaged. The Federal Government had to do something big because the States had no unemployment insurance systems, and no social insurances except workman's compensation. That is all altered now by a vast programme of reforms incorporated in the Social Security Act. He seems intent upon establishing at one stroke the same new social order in the United States that was set up in this country years ago, but great problems are involved, and their solution will teach us much. Another interesting feature is the progressive method of teaching in the schools ; "learn by doing," which we hear about infrequently in this country is a much more recognised system of education in the States.

But while the United States will be anxious to show her English visitors many interesting features of American progress and to almost burden them with kindness, it should be realised that it will be an expression of the relations between Britain and the United States, which were never more cordial than they are to-day. We feel that no effort should be spared to ensure a complete understanding between these English-speaking nations, and each visitor can do much to promote this relationship.

The Right Hon. the Earl of Dudley, M.C.

Dr. C. H. Desch, F.R.S.

Foreword—comprising special messages from the Presidents of the Institutes concerned in the visit to Canada and America

From The Rt. Hon. The EARL OF DUDLEY, M.C.,
President of the British Iron and Steel Institute

I AM very glad that the visits which members of the Iron and Steel Institute and of the Institute of Metals will shortly be making to a large number of steel plants, technical institutions and other works in Canada and the United States, are described in the present issue of METALLURGIA. It is a happy token both of the importance attached to these visits by technical men in all the countries represented, and of the cordial appreciation which these invitations have aroused, that the party which is about to leave is a fully representative one.

As president of the Iron and Steel Institute and also as one of the representatives of the British Iron and Steel Federation who have been concerned in formulating an agreement with the American steelmakers, I was very keen that our party should, in persons and in number, be in a position to return the compliment addressed to us. We shall travel some 300 strong, including, I am glad to say, a number of our leading executives and scientists. Others, I well appreciate, have been prevented by present exigencies of business and other hindrances from joining us, but readers of METALLURGIA will no doubt have an opportunity later on of seeing our gatherings described.

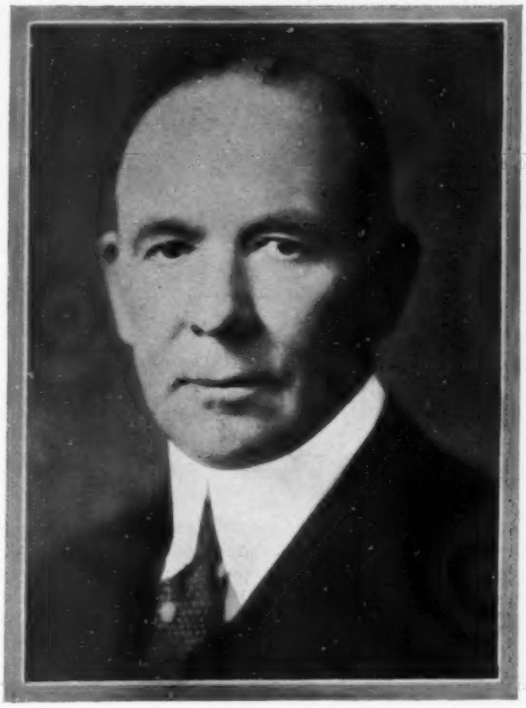
Much of what we shall witness and learn, however, can only be appreciated on the spot, and I am quite sure that the whole steel industry in this country will be the richer in technical knowledge and inspiration as a result of our tour. I myself can share in the pride of repeating that it was inventors in this country who first taught the world the fundamental processes of making steel. After the reorganisation which recovery from a disastrous decade of dumped imports, redundant plant and financial depletion has made possible in the last three years, we can claim in this country to possess iron and steel plants second to none. In actual acquaintanceship with modern processes, I believe we lose nothing to technicians abroad. At one time or another they have something to teach us, and we have something to give them.

A regular interchange of the results of research takes place within the forum provided by the Iron and Steel Institute, the membership for which covers no fewer than thirty-two nations. It would be impossible, however, properly to appreciate current developments elsewhere without these joint meetings which the Institute arranges in each steel-making country in turn. Some of us have unfortunately insufficient opportunity to read and to assimilate the various papers which are presented to the Institute, and it is from these visits to works and laboratories that we look in the main for enlightenment.

As a result of rapid expansion within the American and, to a less extent, within the Canadian industry over the past two years, there never was a better opportunity than the present for personal study on that Continent. I have mentioned that in this country we possess fully up-to-date plants. This does not mean that we have nothing to learn from the results of practice on that large scale which is axiomatic of the United States, but which conditions in Great Britain do not on the whole permit. In this country, because a large proportion of our output is devoted to the export trade, and because we are organised to supply products to a far wider range of specifications than is to be found in America in relation to total production, it is not economic here to operate units of more than a certain capacity.

In America, on the other hand—the natural home of mass-production by reason of the extent of her inland markets—there are two or three large integrated plants the annual capacity of which would account for the total output of British steel. Economies and refinements are sometimes obtainable in plants of this size, which in any

Mr. T. M. Girdler



Mr. D. C. Jackling

case provide tremendous technical interest, and which may stimulate the attainment, ultimately, of similar results under the conditions peculiar to this country.

Those among the readers of METALLURGIA whose work lies principally in the laboratory and testing shop will be the first to appreciate the stimulus to be gained from talks with their opposite numbers in other countries, and there is nothing which our friends in Canada and the United States are not prepared to show us from electrical furnaces to giant strip mills, from non-ferrous specialities to machine tools.

Thanks to the great amount of trouble taken by the organisers, a wide choice of visits is open to members, according to their particular inclinations. Even the least technically minded member should not fail to be impressed by many of the works that are being opened to us, and incidentally, we shall be travelling over some 3,500 miles of country in the Dominion and the United States before taking ship again.

Quite as much as to the opportunities for technical instruction and information which this tour offers, I attach great importance to our being able to compare notes with those whose general problems as steelmakers are not dissimilar from our own. There will be many opportunities for such informal exchanges of views.

It was in the firm belief that competition in the export markets for steel, together with the conditions now resulting from the rapid expansion in steel-making capacity, gave rise to problems of mutual concern, that discussions between British, Continental and American makers were initiated some time ago. As these deliberations proceeded and as trade receded somewhat, they pointed the way to the need for agreement on a more permanent basis.

The successful working of the International Steel Cartel provides proof that the basic problem of steel manufacture, which is to avoid over-expansion in good times and destructive competition in bad, can to a large extent be solved while making adjustments for the special position of each country. There appears to be no reason why the interests of producers across the Atlantic should not be safeguarded through a similar type of accord.

It is clear, therefore, that the visit of the Iron and Steel Institute and of the Institute of Metals to Canada and America, falls at a most opportune time, and as our existing relations with colleagues over there are so well-founded, I feel sure that a great deal of good will be done. Having regard to present political tendencies, it falls more than ever to business men in different countries to consolidate and strengthen their mutual understanding, and no more fertile ground exists, in this respect, than the countries in which the meetings of the respective Institutes are about to take place.

From Dr. C. H. DESCH, F.R.S.,

President of the Institute of Metals

FOR the Institute of Metals, the holding of an autumn meeting in America is a new departure. Autumn meetings have been held in many Continental towns, and have been both popular and successful, but this will be the first occasion on which the members as a body have gone so far afield. An invitation to visit America in 1932 was received from the American Institute of Mining and Metallurgical Engineers, but circumstances led to several postponements, and the renewed invitation, in most cordial terms, was received in the spring of 1936, October, 1938, being suggested as convenient to our hosts and as promising suitable weather for visiting metallurgical plants. The invitation was welcomed by the Council and by the Institute, it being understood that a similar invitation for the same time had been extended to the Iron and Steel Institute and accepted. The two British Institutes will therefore travel together, the arrangements being made jointly, and although the programmes of predominantly ferrous and non-ferrous interest diverge from time to time, they meet whenever possible, and not only for social functions, as many visits and certain of the technical meetings are common to both groups. Our hosts, the American Institute of Mining and Metallurgical Engineers and the American Iron gnd Steel Institute, have spared no pains to make the programme interesting and informative, and the list of metallurgical plants and laboratories which will be open to inspection is so extensive that members who are visiting America for the first time may find it difficult to make a

selection. Care has been taken, however, to avoid overtiring the visitors, and night travelling has been reduced to a minimum. No detailed programme for the ladies has been issued, but there is an attractive list of social functions, and those who have taken part in congresses in America on previous occasions will remember that the splendid private hospitality of our friends in that country ensures that the ladies will see the sights of the towns and the scenery of the surroundings under the most delightful conditions.

It is hardly possible to exaggerate the value of such a visit for the metallurgist. Young men, especially, should benefit, and it is gratifying to know that a number of firms have given facilities for younger members of their staffs to join the party. The United States possess vast mineral resources, greater than those of any other country, whilst the large and rapidly growing population provides a great market for metals, so that the scale of metallurgical production has become increasingly large. The great motor works of Ford and General Motors, and the large strip-rolling mills, of which several will be visited, are examples of this development. At the same time, the practical problems of large-scale operations have called for intensive research, and for many members one of the chief attractions of the tour will be the opportunity of visiting famous research laboratories, such as those of the Bell Telephone Company in New York and of the American Aluminium Company near Pittsburgh, to name only two.

Owing to the community of language, American metallurgical literature is more familiar to most English readers than that of any other nation, and members who study the progress of the science and industry of metallurgy will no doubt be glad to meet in the flesh men whose names are familiar to them through their publications. Our own Institute has a large membership in the United States, and, in addition, we shall encounter the members of the American organisations at the joint meetings in New York, and further opportunities are offered by the "Metals Week" in Detroit, and the associated Metals Exposition, a part of which coincides with our stay in that city.

For a large proportion of the members of the two Institutes, the New York visit will be preceded by a tour in Canada. From Quebec and its surroundings, where one may easily imagine one's self in France, the journey will give a comprehensive view of the eastern part of the great Dominion, and the industrial plants visited will include striking examples of the use of water power on a large scale. The nickel mines at Sudbury, one of the most remarkable mineral deposits in the world, will prove a great attraction. The Canadian tour also includes much picturesque scenery.

Although it has not been possible for all the members and ladies to cross the Atlantic in the same ship, the bookings show that several large parties will travel together, the comparative rest on board a liner affording a welcome preparation for the more strenuous journey and engagements on land, and for reposing on the return and comparing notes with one's fellow travellers. The response to the invitation to take part in the visit has been very satisfactory, and success seems assured. I am grateful to the Editor of Metallurgia for giving me this opportunity of calling attention to the importance of the tour, and for devoting so much space to an account of the arrangements.

From Mr. T. M. GIRDLER,

President of the American Iron and Steel Institute

To the members of the Iron and Steel Institute and the Institute of Metals, may I express, on behalf of the American iron and steel industry, its keen pleasure over the forthcoming visit to the United States of the leaders of the British steel and metal-working industries.

Out of our joint meetings much can be confidently expected along the lines of exchanging technical knowledge, and resultant advancement of the science of iron and steel making. Of even more importance, however, will be the better understanding of our mutual problems, and the strengthening of the ties of friendship and co-operation which are already so well established between the great English-speaking nations.

The projected meetings, together with your visits to many of our principal plants, are evidence of the enlightened form which competition has assumed in your democracy and in mine. In both countries the steel and metal-working industries have provided the material basis of our civilisations, and have made possible much of the tangible progress in our living standards. It is fitting that our industries should likewise be taking the lead in giving expression to the new spirit of mutual helpfulness and sensible co-operation among industries and among nations.

From Mr. DANIEL C. JACKLING,

President of the American Institute of Mining and Metallurgical Engineers

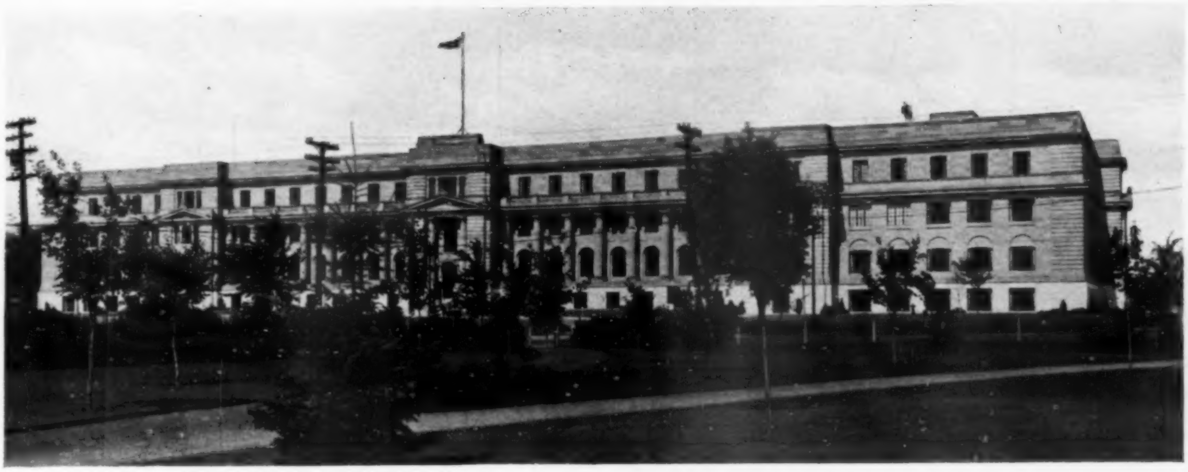
American engineers, especially those engaged in mineral industry and metallurgical pursuits, are looking forward with eager anticipation to the approaching visit of and meeting with the delegations of distinguished members of the British Iron and Steel Institute and the Institute of Metals on the occasion of their forthcoming tour in the Dominion of Canada and the United States. I expect it to be my very agreeable duty and welcome privilege at that time to express orally to our guests from overseas our gratification that both they and we are afforded the opportunities of better acquaintanceship arising from the joint meetings, the inspection excursions, and the social functions scheduled to and at a number of American industrial centres. I and my associates of the A.I.M.E. feel deeply obliged that through the courtesy of the Editor of Metallurgia I am accorded this means of extending a written greeting to a still wider range of British engineers and industrialists and to pronounce the hope that the prospective assemblies will play a very real and lasting part in promoting cordiality and enhancing co-operative understanding not only among all the participating groups, but also among all English-speaking persons who engage themselves either wholly or partly in drawing upon nature's mineral resources and converting these materials to forms best adapted for greatest usefulness to humanity.

From Prof. G. B. WATERHOUSE,

President of the American Society for Metals

Members of the American Society for Metals look forward with the greatest of pleasure to the organised visit of British metallurgists, sponsored by our sister organisations, the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers. May I express the hope that many of the visitors can extend their stay long enough to journey to Detroit, the automobile centre, and attend our annual convention and National Metal Exposition during the week of October 17. We will regard each of you as one of us, to enjoy equally the privileges of our members at all occasions during that week.

The present writer, being an Englishman by birth and education, can testify from innumerable personal experiences as to the cordial reception his English cousins will receive from his compatriots. Come and let us show you!



Canada's National Research Laboratories at Ottawa.

Visit to Canada and the United States of America by British Institutes

A summary of the visit of the British Iron and Steel Institute and the Institute of Metals to Canada and the United States is given, together with brief reference to many of the cities and towns included in the tour, and brief reviews of some of the works and laboratories which members plan to visit.

THE joint meeting of the British Iron and Steel Institute and the Institute of Metals, will be held in New York on October 3 and 4, 1938, as a result of invitations received by both British Institutes from the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers. In addition to the meeting, tours have been arranged in Canada and the United States. For the former, the Canadian Institute of Mining and Metallurgy have agreed to act as hosts. Many towns and cities in both countries, and also important works and industrial concerns, will be visited. The visit to Detroit coincides with the "Metals Week" and "National Metals Exposition" organised by the American Society for Metals, and members of the British Institutes are invited to participate in its programme.

The great importance of this meeting between leading societies, representing as they do the most vital industries of these countries, cannot be emphasised too strongly, not only from a technical and metallurgical point of view, but as a factor in the promotion of friendly relations between the English-speaking peoples. History has shown that world prosperity and peace are closely linked by such friendly relations and close co-operation, and this meeting should, and we believe will, be a happy augury for the maintenance of those friendly relations which have been enjoyed by the peoples in the North American Continent and Great Britain.

Several hundred members and guests will participate in this visit; for various reasons, however, the greater number of members of these Institutes are unable to take advantage of the opportunities it presents, and in view of the interest taken in this meeting brief information regarding some of the districts included in the visit and of some of the works is presented in the following summary. As will be readily imagined, some of the industrial concerns which are to be visited are so large and comprehensive that a complete description would occupy more space than can be given here to the complete visit, thus only brief reference can be given to some of the laboratories and works included in the itinerary, but every effort has been made to ensure the accuracy of the particulars, so that they may prove to be informative as well as interesting. The visit is divided into various sections, and for convenience the planned arrangements will be adhered to as far as possible.

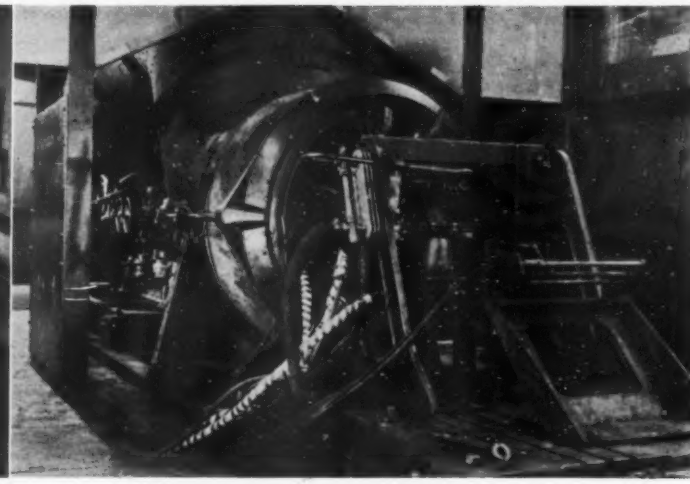
Section I—Canada to New York

THE majority of members and ladies who have selected this section will make the transatlantic crossing in R.M.S. *Empress of Britain*, which is due to arrive in Quebec about midday, September 22, and after an informal luncheon at the Hotel Chateau Frontenac, will welcome the opportunity of seeing the city and its environs, particularly as the arrangements leave little time for other than a superficial view. There is much of interest in this city, consisting as it does of an old and a new town, with steps leading from one to the other.

Quebec

Rich in historic interest, Quebec is the seat of provincial government in that province. It is bounded on the south by the St. Lawrence River, and on the north by the valley of the St. Charles. Quebec is built on a narrow promontory, below the 200–300 ft. cliffs of the St. Lawrence which extend for several miles. There is a unique monument in the Governor's Gardens, the only memorial, we believe, in the American continent which commemorates both victor and vanquished. This is a plain granite column with the name

Model testing basin in the laboratories of the National Research Council, where much valuable data pertaining to aircraft floats has been secured.



Armstrong-Siddeley 14-cylinder "Jaguar" engine undergoing fuel investigation on the dynamometer in the laboratories of the National Research Council at Ottawa.

of Wolfe on one side and that of Montcalm on the other. In the upper and lower market towns visitors will see life typical of the French Canadian, with many evidences of the influence of the old French regime. The city is modern in regard to lighting and cleanliness ; all spare ground is converted into small gardens, and the hotel accommodation ranks with the best in Canada. The principal thoroughfare is the Grand Allée, and there are numerous places of picturesque and historic interest in the immediate neighbourhood—the Parliament buildings and grounds are as good, if not better, than those of the larger Canadian cities. These, together with the Peace Tower and the Royal Victoria Museum, will be included in the itinerary.

A special train conveys the party from Quebec to Montreal the following morning, breaking the journey at Trois Rivieres, from which members and ladies are conveyed to Shawinigan Falls, where they will be the guests of the Shawinigan Water and Power Co., Ltd. In addition to the Power Development Plant, visits will be paid to Aluminum Plant, Cellophane Plant, Carbide Plant,and Laurentide Paper Mills of the Consolidated Paper Corporation at Grand Mere. Considerable interest will be taken in the aluminium smelters of the Aluminium Company of Canada, Ltd., which, under its former name, the Northern Aluminium Co., Ltd., was one of the first industries to locate at Shawinigan Falls.

Montreal

Regarded by many as the largest and most important city in the Dominion, Montreal lies on the north bank of the St. Lawrence, in the province of Quebec, 985 miles from the Atlantic coast, 180 miles south-west of Quebec, and 420 miles north of New York. It is in the middle of a great plain traversed by the St. Lawrence and the Ottawa rivers, which rivers meet at the head of the Island of Montreal, this being 32 miles long and 10 miles wide at its maximum. The city is built on the south-east side of the island, and at a point where the Lachine Rapids prevent further navigation. Behind the city rises Mount Royal, to a height of over 750 feet. This is now a park, with its natural beauty carefully preserved ; a terraced roadway makes a complete circuit to the summit, providing wonderful views.

Show places are the Place d'Armes, with a statue in honour of Sieur Chomedy de Maisonneuve, the founder of Montreal ; the Jacques Cartier Square facing the river, Victoria Square, Dominion Square, and St. Helen's Island. Members, however, will take the opportunity of visiting some of the important works in this district.

The arrangements include a wide choice from such large and important companies as Canadian Copper Refiners, Ltd., and Canadian Wire and Cable Co., Ltd., for the production of copper and one of its important applications ; the Canada Metal Co., Ltd., for those interested in lead and tin ; the Canadian Vickers, Ltd., where shipbuilding and aircraft construction will be seen ; or the manufacture of alloys at St. Lawrence Alloys, Ltd. Included is a visit to Canadian Steel Foundries, Ltd., brief particulars of which are given here.

CANADIAN COPPER REFINERS LTD.

A Canadian copper refinery which should provide much of interest to visiting members is Canadian Copper Refiners, Ltd., whose electrolytic copper refinery at Montreal East, Quebec, has an annual capacity of 75,000 tons. This plant is operated on the custom basis. The company is controlled by Noranda Mines, Ltd., being a subsidiary of that concern, and has a contract with the Hudson Bay Mining and Smelting Co. to refine up to 15,000 tons of blister copper annually. The production of selenium commenced in 1934, and of tellurium in the following year.

THE CANADIAN STEEL FOUNDRIES LTD.

FORMED in 1909, this company was a merger of the then existing car plants in Canada. In 1912 three of the larger steel foundries in Canada were acquired, and also a malleable iron foundry. To-day the company is composed of eight plants located from Fort William, Ontario, in the west to Amherst, Nova Scotia, in the east. At these plants are built freight and passenger railway cars of all descriptions, motor-'buses, trucks, etc., as well as their accessories, and also foundry products too numerous to mention here. The Fort William plant is confined exclusively to the building of aeroplanes.

The Longue Pointe plant, to which special reference might be made, was rebuilt in 1912, and the first heat taken off in July of that year. This is the largest steel foundry in Canada, having a capacity of from 4,000 to 5,000 tons of steel castings per month, and employing normally about 1,700 men. It is well located with respect to rail and road transport, having a siding upon the Canadian National Railways, and being connected directly with Notre Dame Street, one of the main arteries of Montreal.

The buildings are lofty and substantial, being of the steel framed construction type with brick filling, and are well served by electric overhead cranes, up to a capacity of 50 tons, of which there are 30 in service in the various departments. This foundry is admirably equipped, and particular attention is directed to the electric and open-

hearth furnaces, to the facilities for the heat-treatment of castings, and the cleaning equipment. Ample yard space is available for the storage of scrap, pig iron, limestone, and moulding sand; these materials are located in numbered bins, and are handled by locomotive steam cranes fitted with grab buckets and lifting magnets according to requirements; a good system of yard tracks facilitates the handling of materials, moulding boxes and finished products.

The products of this foundry are very diverse, including not only a complete line of railway-car and locomotive castings, but also a large tonnage of rolling-mill rolls, manganese steel castings, for railway track and mining work, etc., as well as large runners and other castings in connection with hydraulic power development. Ship construction castings, such as stem and stern frames, rudder-posts, etc., are also undertaken, together with a complete range of general castings for various purposes ranging from a few pounds to several tons in weight.

Top.—Part of one of the foundry bays at the Longue Pointe plant of Canadian Steel Foundries.
Bottom.—A steel slag ladle with a diameter of 9 ft. 9 in. and 7 ft. 10 in. in height.

Ottawa

The party leave Montreal for Ottawa on the morning of September 25. The journey is via the Seigniory Club, where the day will be spent by arrangement with members of the Montreal Branch of the Canadian Institute of Mining and Metallurgy; members and ladies arriving in Ottawa in the evening.

The following morning many will take advantage of the facilities afforded for sightseeing in the city. Ottawa, the capital of the Dominion, in the province of Ontario, is well placed at the junction of the Ottawa and Rideau rivers, 120 miles west of Montreal. Visitors cannot fail to be impressed by two Falls: the Chaudiere Falls in the Ottawa River, which are 600 ft. wide and 40 ft. high, and the Rideau Falls, which carry the Ottawa River toward the eastern end of the city. Both these Falls supply extensive water power. Ten bridges cross the Rideau within the city, and a road bridge spans the Ottawa below the Chaudiere Falls. A driveway which encircles the city, over a total of some 30 miles, will be found particularly attractive. Buildings worth inspection are the Parliament and Government buildings (125 ft. above the river, and in Italian Gothic style), the Langevin block facing the Houses of Parliament, the Peace Tower, Rideau Hall, Victoria Museum, Royal Mint, the Observatory, and the National Archives.

It is noteworthy that both members and ladies have the opportunity of visiting the Royal Mint and Laboratories of the National Research Council, or the Laboratories of the Bureau of Mines, which will be both interesting and instructive. Brief information regarding the formation and development of the National Research Council and its Laboratories, and also of the visit to Sudbury, which is provided as an alternative in the arrangements, will prove of interest.

THE NATIONAL RESEARCH LABORATORIES OF CANADA

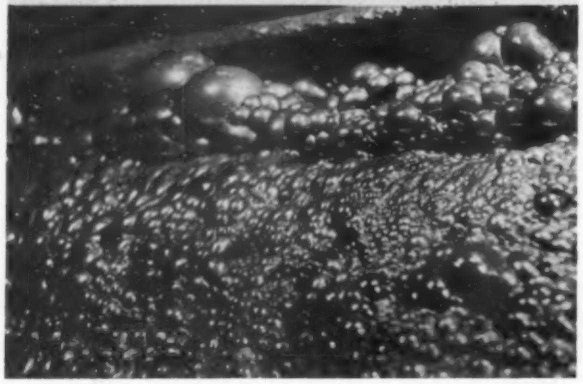
IN Canada the organisation of research as a function of government dates back to the impact of the Great War. In 1916, Canada, following the example of Great Britain, established an Honorary Advisory Council for Scientific and Industrial Research. It was not contemplated at that time that this Council should set up laboratories of its own; it was to act as an agency for consultation and co-ordination between those already carrying on research in the established laboratories of the several departments of the Dominion and Provincial Governments, in the universities and in industry.

Looking back at the history of the Honorary Advisory Council for Scientific and Industrial Research, it is remarkable what has been accomplished with the limited facilities at their disposal, but it is not to be wondered that men who were informed on the subject should have realised the utter inadequacy of the provision which had been made and that they should have pressed for some improvement. As the result of this pressure of public opinion, the matter was repeatedly considered in Parliament, and eventually the Research Council Act was passed in 1924. Work continued for several years in temporary laboratories. Then in 1929-30 Parliament provided funds for new laboratories; construction was commenced in February, 1930, and the buildings were completed and opened in 1932.

The new building of the National Research Laboratories stands on a 10-acre site beside the beautiful Rideau Falls, which marks the confluence of the Rideau and Ottawa Rivers. Severely classic in style, with a colonnade of eight Roman Doric columns on each side of the central entrance, the building has four storeys and basement, and encloses two large interior courtyards, giving ample light to the overlooking laboratory rooms.

The National Research Council to-day consists of 15 members, selected, for terms of three years, from among men prominent in scientific work in Canadian universities or in Canadian industry. The Council meets four times annually, and the President reports directly to the Committee of the Privy Council on Scientific and Industrial Research. Scholarships, to encourage post-graduate study in Canada, are awarded annually by the Council.

Present and major activities of the laboratories, in the Division of Chemistry, include both industrial investigations and researches in pure science. At the moment, major emphasis is placed on industrial research, these including



Top.—Flotation machines in the plant of the International Nickel Company of Canada, Ltd., Copper Cliff, Ontario. Two separate concentrates, a nickel concentrate and a copper concentrate, and a tailing are made.
Bottom.—A close-up view of the metallic bubbles coming off one of the flotation machines in the production of the nickel concentrate at the Copper Cliff plant.

investigations supported financially by industry and those undertaken by the Division for the purpose of assisting the solution of problems of national significance. In the former category investigations have been made on asbestos, laundering, and dry cleaning, leather, refractories, and rubber, and in the second category work has been done on the utilisation of waste natural gas by the production from it of carbon black and motor fuel, on the corrosion of metals, paints, potato starch, the use of Canadian clays in refining oils, storage batteries, and textiles.

The Division of Mechanical Engineering comprises aeronautical and fire hazards laboratories and instrument and model shops. A large part of the work of the aeronautical laboratories is done for Government departments, particularly for the Departments of Transport and of National Defence, with whose officers the closest collaboration is maintained. The equipment of this Division includes a wind tunnel capable of developing velocities up to 160 m.p.h., and a testing basin 400 ft. by 9 ft. by 6 ft., with a carriage having a speed of more than 40 ft. per second, for aeronautical and marine research, an engine laboratory where aircraft engines, or any other type of prime mover of capacities up to 1,000 h.p. at 2,500 r.p.m., can be tested, a laboratory for testing fire hazards, an instrument laboratory, and workshops.

Other research has been of a non-aeronautical character, such as the streamlining of locomotives and the design of ships' hulls, and windmills. In the fire hazard laboratory exhaustive tests are made on domestic oil burners prior to the approval of types of construction submitted. An aeronautical museum is being established to preserve obsolete material of historical interest connected with the development of aviation in Canada. Engines, aircraft propellers, models, and similar specimens commemorate important Canadian contributions to the development of aviation.

In the Division of Physics and Electrical Engineering, researches are conducted on sound, with particular reference to sound insulation, heat and heat insulation, light measurement and spectroscopy, radio and atmospherics, ultrasonics, radium and X-rays, as well as on specific problems in the fields of physics and electrical engineering. This Division is responsible for the maintenance of the fundamental Canadian reference standards for the measurement of mass, length, light, radium and X-ray radiation, also electrical resistance, voltage, current, and other quantities relative to these. Although it maintains the legal standards established by the Weights and Measures Act, the Division does not certify devices for legal use in trade, this being the responsibility of the Department of Trade and Commerce.

It is expected that a large number of members will take advantage of the cordial invitation extended by the President of the National Research Council to inspect the laboratories.

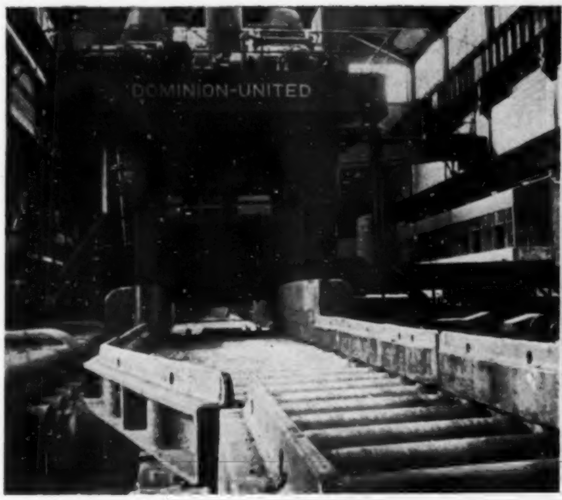
Sudbury

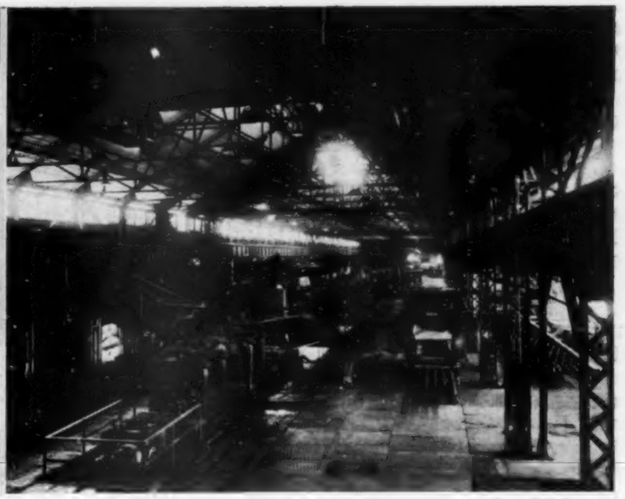
This comparatively small town in the district of Nipissing, Ontario, is 75 miles west of North Bay, on the Canadian Pacific, Canadian National and Algoma Western railways, some 443 miles west of Montreal. Its main industry is provided by the nickel and copper mines, and this visit is by invitation of the International Nickel Co. of Canada, Ltd.

As is well known, the nickel produced in Canada has its source almost entirely in the nickel-bearing ores of this district. The known reserves of nickel ore in this district are by far the largest in the world, being estimated at over 200,000,000 tons, carrying, perhaps, on the average about 3% nickel and 2% copper, though the grade varies greatly in different mines. Ores from Creighton mines, for example, carry about 5% nickel, while some of the ores in the lower levels of the Frood mine carries as much as 20% copper. The largest individual ore body—that at Frood—has only been partly explored as yet, but over 125,000,000 tons of ore are so far indicated. Production and developed reserves in this district are entirely in the hands of two companies, the International Nickel Co. and Falconbridge Nickel Co. The former, the host to the party visiting Sudbury, is the larger, being capable of mining, concentrating, and smelting about 13,500 tons per day, while the capacity of the Falconbridge is about 1,200 tons per day.

It is noteworthy that the Falconbridge Co. treat the ore in a blast-furnace, when most other smelters use reverberatory furnaces. The medium grade ore at Falconbridge, being higher in nickel than in copper, and possessing a high sulphur content, is found to be suited to smelting in the blast-furnace. Though there are a number of influences that might upset the balance in this type of smelting, by keeping within certain limits there is achieved at Falconbridge a better recovery of the metals at lower costs than would be possible by the alternative methods.

It should be noted that the rate of copper production by both the International and Falconbridge companies is dependent on the demand for nickel, not copper; nevertheless, there is normally a satisfactory market for all the copper produced. Considerable developments have been carried out by the International Nickel Co. of Canada, Ltd. Two new reverberatory furnaces have recently been put into operation at Copper Cliff, together with some new converters, which have increased the capacity of this smelter from 15 to 20%. The effective force of reverberatory furnaces is now seven, although only six of these are in operation at one time. The recent addition of seven new converters brought the total to 19. The converter "aisle," together with the adjoining Orford section, has a length of more than 2,100 ft. In the expansion is a new 510 ft. smoke stack and the construction of a copper research laboratory, close to the main office building, will prove interesting to many members.





Showing the 34-in. blooming mill and on the right a general view of the sheet mill at the Hamilton plant of the Steel Company of Canada, Ltd.

Considerable progress has also been made at the Frood mine. Originally planned for a daily production of 10,000 tons, the Frood mine is at present providing over 11,000 tons per day for the Copper Cliff smelter. Ore for the Coniston blast-furnace is coming from the Creighton mine, and the total volume of ore undergoing treatment at the International Company's various plants at Sudbury averages about 13,500 tons daily. With further developments made at the Creighton mine, production is being increased to relieve the load on the Frood mine.

The rated capacity of the Ontario Refinery Co., now wholly owned by International Nickel Co., is 10,000 tons monthly. Recently this company brought into commercial production the smelting of copper cathodes in an arc-type electric furnace of 30-ton capacity. This is regarded as an outstanding development in the copper refining industry. In addition, a machine is in operation for double-pointing vertically-cast copper wire bars. Visitors will be particularly interested in the method of receiving blister copper in the molten state, which was tried experimentally in 1936. The method has been perfected, and several movable holding furnaces are now in operation between the smelter and refinery, transporting the blister output of the smelter a distance of 2 miles to the refinery's anode furnaces. Although this method is familiar in the steel industry, it is claimed to be the first time it has been applied on a large scale in the handling of blister copper.

Toronto

Those members not visiting Sudbury, and all ladies, arrive in Toronto in the evening of September 27, while the Sudbury party travel overnight and arrive in Toronto the following morning. This lakeside port is the capital of the Province of Ontario, situated at the mouths of the Don and Humber rivers, in the bay of Toronto and on the north-west coast of Lake Ontario, 313 miles from Montreal in west-south-west direction, and is connected with the other principal cities of Canada by the Canadian Pacific and Canadian National railways. It has a water front of ten miles from east to west, and the harbour can accommodate 100 or more vessels, ranging from 5,000 to 15,000 tons. Important public buildings are the Parliamentary block, City Hall, Central Library, Maple Leaf Stadium, Royal Ontario Museum, and the building of the Canadian National Exhibition. There are 70 parks, of which High Park and Exhibition Park are noteworthy examples. The city derives its name from an Indian Huron word meaning "place of meeting."

In addition to a sightseeing tour in and around Toronto, arrangements have been made to visit such works as the Anaconda American Brass, Ltd., Canadian Wire and Cable Co., Ltd., De Haviland Aircraft of Canada, Ltd., and John Inglis Co., Ltd.

From Toronto the party journey to Niagara Falls, the ladies direct, but members via Hamilton, where several works are visited, including those of the Steel Company of Canada, Ltd., Dominion Foundries and Steel, Ltd., International Harvester Co., Ltd., Canada Works of Steel Co. of Canada, Ltd., and Canadian Westinghouse Co., Ltd. Brief reference to two of these firms will be of interest.

STEEL COMPANY OF CANADA, LTD.

FIVE groups of some forty-eight firms were incorporated on June 9, 1910, to form the Steel Company of Canada, Ltd., each with a tradition of years of industrial experience. The advantages of the consolidation were announced in the original prospectus as being: Reduction in the cost of administration; the achievement of reduction in the purchase of supplies and material; and increased efficiency by specialisation of the manufactures of the individual plants and the avoidance of unnecessary duplication.

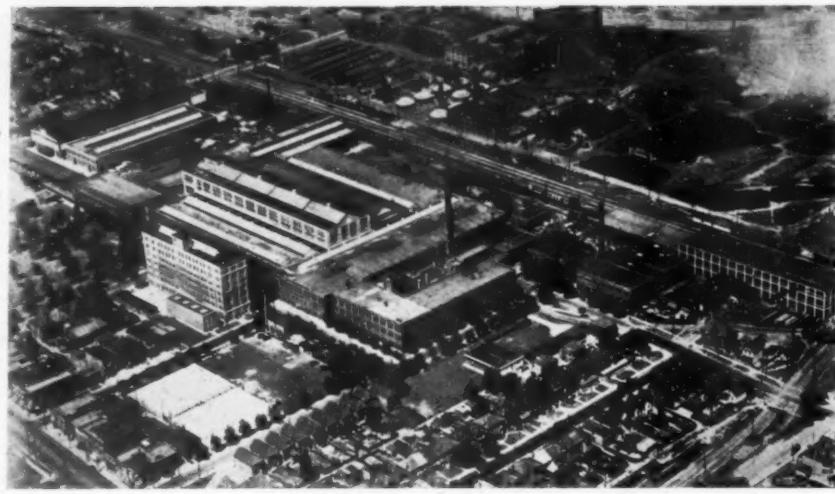
The manufacturing activities of the Steel Company of Canada, Ltd. cover a range which includes all the important steel products in common use, comprising a wide diversity of articles and making this company manufacturers of a greater variety of products than any other steel company in that continent, and probably in the world. Lead shot is one of the products resulting from the amalgamations which took place, the Notre Dame works in Montreal possessing the only operating shot tower in Canada. Shot was first dropped there in 1860. The equipment has been progressively modernised, and in 1931 a concrete tower of unique design was built, forming an outstanding landmark in the lower part of the city.

A scattered array of primary producers gradually appeared in the Eastern Provinces of Canada, whose major need was an assured outlet for the products of their furnaces, whilst the established finishing mills were handicapped through uncertainty of supply of reasonably priced material of uniform quality. On account of the multiplicity of interests, a union such as was projected presented much difficulty, and it was due to the organising ability of W. M. Aitken (Lord Beaverbrook) that the merging of five well-financed groups of producers into a working corporation owed its original impetus.

Blooming, billet and rod mills for the supply of steel to the finishing mills of the new corporation commenced operation in 1912 and 1913. The outbreak of war in 1914 created a demand for steel that taxed the capacity of the company to the limit, but they rose to the occasion and the

total output of shells alone exceeded 880,000. By-product coke ovens were installed in 1917, and in the same year, by fast work, a fully equipped sheet mill was completed. In 1919 plant for recovery of benzol and other fuels and solvents was added to the coke plant, and a pig-casting machine was installed to replace the old sand casting at the blast-furnaces.

One of the most important factors was the establishment of a uniform sales policy, and from 1920 the flow of domestic business sought readjustment to the new economic conditions of the period immediately following the War. One result was a clearer realisation of the necessity for accurate cost control. The tube mill at St. Henry was remodelled throughout in 1925, equipment including means for freeing the pipe from scale and improving its corrosion-resistance properties. In the same year the Swansea works was developed to supply bolts and track accessories to the new heat-treating requirements of the railways.



General view of the main plant of the Canadian Westinghouse Company, Ltd.

Plans for developments at Hamilton were carried out in 1928 and 1929, and included two new 150-ton open-hearth furnaces and a 12-10-in. merchant mill designed specially for Canadian trade conditions. The wire galvanising department at Dominion works, Lachine, Quebec, was remodelled to come into line with advanced practice, with increased space for storage of wire rods and the manufacture of various types of fencing. At Hamilton works a system of distributing adjusted mixtures of waste blast-furnace and coke-oven gases for the requirements of the mill attracted great attention from American steel operators, this being the first such installation to be made in either North or South America. The Canada works was also remodelled, to supply special types of wire, including galvanised, high-carbon, and heat-treated.

1931 saw the opening of the improved and deepened Welland Canal, and a coal and ore dock was completed, making a material reduction in the cost of handling the great tonnage of basic necessities. A new physical testing laboratory was installed at Hamilton in the same year, and was acclaimed as the finest of its kind in Canada. Its research work was particularly directed towards the study of low alloy and controlled steel production.

One result of the trade depression which started in 1930 was that more intensive efforts were called for to overcome a contracted sales volume, and there was a call for special products not previously obtainable from Canadian producers. Many orders demanded goods to entirely new requirements or specification, and there gradually accumulated on the books of the company no less than 1,100 separate specifications for steel, including 800 special types for individual requirements.

The Brantford works produces bolts and nuts; the Canada works at Hamilton manufactures wire and wire nails; wire and wire products, fencing, screws, and horseshoes are produced at the Dominion works at Lachine; the Hamilton works have two blast-furnaces with a capacity of 340,000 tons of pig iron per annum, 80 Wilputte by-product ovens, by-product recovery plant, 11 open-hearth furnaces ranging from 50 to 175 tons, blooming, sheet, bar and billet, as well as sheet mills, together with box annealing, blue annealing, and normalising furnaces, pickling machines and galvanising pots. There is also a 12-in. roughing and 10-in. finishing rod mill with yearly capacity of 150,000 tons.

The Notre Dame works produces plain wire, galvanised and tinned wire, nails, tacks, bolts, nuts and rivets. At the Ontario works is a 20-in. bar mill producing splice bars, tie-plates, merchant bars, and rolled blooms and billets; the St. Henry works in Montreal produces pipe, with yearly capacity of 22,000 tons of butt-welded piping from ¼ in. to 4 in., and a galvanising capacity of 13,000 tons. Bolts, nuts and rivets are fabricated at the Swansea works, Ontario, and the Western Wire and Nail Works at London, Ontario, has a yearly output of 1,800 tons of wire nails.

THE CANADIAN WESTINGHOUSE COMPANY LIMITED

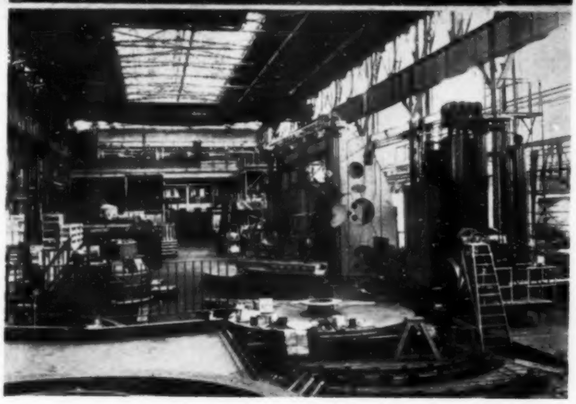
THIS Company is a manufacturer of electrical apparatus of every description, from the largest water-wheel generator to a Mazda lamp. The original Westinghouse Company was founded in 1896 to manufacture air brakes for steam railways, but in 1903 a reorganisation was effected whereby the present name was adopted, and electrical products and accessories and air brakes for steam and electric railways were added to the list of products.

The Company manufactures water-wheel generators up to 65,000 h.p., such as are installed in the principal hydro-electric generating stations in the country. Of the 8,000,000 h.p. already installed and in operation in Canada, nearly one-half of it is being generated through Westinghouse machines. Transformers and circuit breakers to handle circuits up to 220,000 volts have also been built. The Company was the pioneer in Canada of metal-clad switchgear and supervisory control. Electric motors of every rating and size have been built in Hamilton, from the fractional horsepower motor for vacuum cleaners up to a giant 7,000-h.p. D.C. blooming mill motor for a steel plant. Instruments and watt-hour meters, and a host of allied electrical equipment, as well as a complete line of domestic appliances, are also made by this Company.

The Company now has two complete plants at Hamilton, comprising an area of 53 acres; the main plant embraces all the manufacturing activities of the Air Brake Division and the Electric Division, except foundry work. At the west plant are carried on all the foundry operations of the Company, and such allied activity as pattern-making. In this connection it may be noted that the brass foundry in the west plant is completely electrified and is well worth a visit. At the west plant the departments for lamp and radio valve manufacture are located. Two enamelling furnaces take care of the production of refrigerator cabinets, electric ranges and washing machines, all of which utilise the most complete equipment to produce the superior products for which Westinghouse is noted.

The Canadian Westinghouse Company have a Benefit

Moulding aisle in the iron foundry of Canadian Westinghouse Company, Ltd.



Waterwheel generator assembly at Canadian Westinghouse Company, Ltd.

Department, and a scheme of group life insurance is in effect. The Veterans' Association, which comprises all employees who have seen more than 10 years' service, now numbers over 1,900, out of a total pay roll of approximately 4,000 to 4,500. The Company maintains district offices and service and repair shops throughout Canada. In the manufacture of such a wide list of products the Company supports local and national industries very materially, and is, therefore, a vital part of the country's economic system. Metallurgists will be interested in seeing the latest types of machinery in operation in various divisions, one of the largest boring mills in the country, and an ignition welder which accurately times welds down to 1/15,000 of a second by which not only visible welds may be made but dissimilar metals may be welded together; automatic screw machines, balancing machines, and a great many others, showing the visitor that this Company is most progressive.

Niagara Falls (Ont.)

Members are due to arrive in this small town during the afternoon of September 29. Situated on the west bank of the Niagara River, and set below the Falls, opposite its namesake across the river in the United States, this town affords the best views of the Famous Falls. It is connected with the American town by three bridges, and is a station on the Michigan Central, Canadian National Grand Trunk, and Wabash Railways. The finest view of the Falls is from Queen Victoria Niagara Falls Park, which extends above and below the Falls for about 2½ miles. Members will note that the enormous electric power plant is larger here than on the American side.

The following day members journey to Buffalo to visit the Lackawanna plant of Bethlehem Steel Co. or the plant of Bliss and Laughlin, Inc., the former a very large plant comprising ore docks, blast-furnaces, steelworks, rolling mills, including a 79-in. continuous sheet mill, bar mills, and die rolling; and the latter a modern plant for the production of cold-drawn bars. Despite these "attractions," it is probable members will desire to see something of the town of Buffalo, since this will be the first journey of the party into the United States.

Buffalo

Situated at the north-east corner of Lake Erie, at the upper end of the Niagara River, is Buffalo, the county seat of Erie County, in the State of New York. It is 433 miles from New York and 540 from Chicago. Street planning is very like that of Washington, D.C., with broad and well-lighted streets lined with trees. Here, too, there are numerous parks, the largest of which is the Delaware, which includes a large lake, this being in the northern section of the city.

From the industrial point of view, a prominent feature is the large ore-unloading docks and cranes at the end of the State Barge Canal, together with extensive flour mills and huge grain elevators. The Peace Bridge, dedicated in 1927, connects Buffalo and Fort Erie. Transport facilities, other than by water, are well exemplified by the 265-mile highway, which extends from Buffalo to Pittsburgh. It is an important trans-shipping point for traffic passing down the Great Lakes and then to the coast.

A feature of the city is the beauty of its residential section; houses generally being of the detached type, enclosed by pleasant lawns and set well back from the streets. The Allbright Art Gallery and the building of the Buffalo Historical Society, with library and museum, stand in Delaware Park, and the museum of the Buffalo Society of Natural Sciences is in Humboldt Park.

Niagara Falls, N.Y.

Instead of visiting either of the plants at Buffalo, some of the party plan to visit Union Carbide Research Laboratories, Carborundum Company, or Titanium Alloy Manufacturing Co., at Niagara Falls, N.Y. Others visit the International Nickel Co. of Canada, Ltd., at Port Colborne, or Atlas Steel, Ltd., at Welland. On the other hand, members and ladies may inspect the Ontario Hydro-Power Development during the morning and enjoy sightseeing and a drive near the Falls, but all will take an opportunity to see at least part of this interesting city.

The city is in Niagara County, some 22 miles west from Buffalo. The Niagara River, which runs somewhat west by north from Lake Erie for 20 miles then descends for a half mile in a series of rapids and cascades, finally plunging over the Niagara escarpment. This escarpment is divided into two Falls—the American Fall is 167 feet high, with a comparatively straight crest of 1,060 feet, but on the Canadian side are the Horseshoe Falls, 158 feet high, curving deeply in the centre of the 2,500-ft. crest, and running at a right-angle to the river. It is estimated that the Canadian Falls carry as much as 90% of the water. Behind the Luna Fall, a small section of the American Fall, is the Cave of the Winds, a water-eroded rock chamber about 75 ft. × 100 ft.

From the Falls the river again descends in a series of rapids through a rocky gorge whose sides tower 200 ft. to 350 ft. above, for about three miles, then reaching a great circular basin, where the tremendous force set up by the change of course of the river creates the Whirlpool. This is an impressive sight, and the rapids below can be said to compete with the Falls themselves for scenic charm.

The various parties leave for New York, in which they are due on October 1.

UNION CARBIDE AND CARBON RESEARCH LABORATORIES

UNION Carbide and Carbon Research Laboratories, Inc., is a research organisation having a total staff of about 150 men, more than 50 of whom are trained

General view of the main research building of Union Carbide and Carbon Research Laboratories.

engineers. The organisation comprises two parts, known as the Research and Development Divisions, both of which are located in Niagara Falls, New York, in close proximity to the Niagara works of the Union Carbide and Electro Metallurgical Companies. The executive offices are in the Carbide and Carbon building in New York City.

The Research Division, the larger of the two, handles research problems for a number of the operating units of Union Carbide and Carbon Corporation, including the Union Carbide, Electro Metallurgical, Haynes Stellite, Linde Air Products, Oxweld Acetylene, Oxweld Railroad Service Companies, and the Prest-O-Lite Company, Inc. At times special work is also done for other subsidiaries of the Corporation, including Carbide and Carbon Chemicals Corporation and National Carbon Company, Inc., although these companies, as well as some of the companies previously mentioned, have research organisations of their own that carry on the major portion of their research work.

The problems of interest to these companies lie in a wide variety of fields and embrace the design and manufacture of new steels and alloys, including structural, engineering, corrosion-resistant and wear-resistant steels, the oxy-acetylene welding and cutting of steel, cast iron and alloys, the design and manufacture of welding rods for such welding, the electric welding of the plain carbon and alloy steels, the design and manufacture of rods and fluxes for this work, and the development of new and improved cutting tools of special type, such as Stellite. Another important line of endeavour in the railroad field, carried on for Oxweld Railroad Service Company, includes welding and cutting problems in connection with locomotive and car building and maintenance, as well as the maintenance of way, the butt welding of rails, the hardening of rail ends to prevent batter, the building up of worn rail ends, frogs, switch points, etc., and the building up of worn locomotive and car parts, together with the design of new welding rods and the design and building of new and experimental equipment for these various processes.

The laboratory is equipped with machines and apparatus for the making of small melts of ferrous and non-ferrous metals, rolling, forging and heat-treatment of the ingots produced in this way, and the subsequent testing by the usual static and dynamic machines. Among the special equipment is apparatus for determining the high-temperature creep strength of various steels, for the fatigue testing of full-sized rail sections, for determining the performance of lathe tools, for spectrographic studies of metals, and for the study of corrosion resistance of metal.

Naturally, a highly trained technical staff is required to undertake problems in such a wide variety of fields as those mentioned ; therefore, members of the staff are specialists in the electrical, mechanical, metallurgical and chemical

South of the great ore reserves in the Sudbury basin and the Copper Cliff operations of the International Nickel Company of Canada, Ltd., located in Port Colborne, in the industrial district of Niagara, and on the Great Lakes waterway is the refinery producing electrolytic nickel. The illustration shows a section of the plant with Port Colborne in the background.

engineering fields, or are highly trained in thermodynamics, gas engineering, the making and treating of steels and alloys, machine design, and the working, machining and fabricating of metals.

The work of the Development Division, which supplements that of the Research Division, is carried out on a semi-manufacturing scale. Here research is carried on for the ferro-alloy, carbide and steel industries. This division has equipment suitable for production of ferro-alloys and steels on a good-sized experimental scale, including electric furnaces for producing ferro-alloys and steels, an open-hearth steel furnace, and a small foundry for production of iron and alloy castings. Other facilities of the division include a reverberatory roasting furnace and ore-dressing equipment for the experimental processing of ores used in the alloy industry. A pilot-scale chemical plant is available for semi-commercial chemical processing of ores and intermediate poducts.

The building in which this division is housed is constructed of steel, brick and glass, and has a floor area of 80 ft. × 260 ft. It is one of the first factory-type buildings in which the steel structure was fabricated entirely by oxy-acetylene welding. Elimination of rivets permitted a design of steel structure which, although equally strong, contains 10% less steel than the conventional type of riveted construction.

Section II—Visit to New York

THOSE members and ladies from the previous section who have planned to include this section in their programme will be joined by a party from the S.S. *Samaria*, which is due to arrive in New York on the morning of October 2. A further party is making the transatlantic crossing in R.M.S. *Queen Mary*, which is due in New York on the morning of October 3. Members and ladies will welcome the opportunity of having a sightseeing drive in New York City, brief information on which is given here.

New York City

The city is located on New York Bay, at the mouth of the Hudson River, and extends along the Atlantic Ocean eastward from the Bay, the larger part of the city lying east of the Hudson, but Staten Island, adjacent to the New Jersey shore, forms an important part of the city. Being built on an island, Manhattan Island, communication between the city and the mainland is vital, and is provided by three suspension bridges and a cantilever bridge connecting New York with Queensborough ; the river between Manhattan and the Bronx is spanned by eight road bridges, two elevated railway bridges and subway tunnels. The Hudson tunnel is an engineering feat that will be appreciated. The ferries, too, carry a great deal of passenger traffic.

To visualise the city, and to embrace some of its many features of dominating interest, we may follow in imagination the course of Broadway, that famous thoroughfare which spans the city from end to end. Starting at Bowling Green, it cuts across the city and terminates at Yonkers, at 262nd Street, 16 miles distant. It passes the western end of Wall Street, bends left at Grace Church, crosses Union Square, then follows the route of the historic Albany Post road, intersects Fifth Avenue at 23rd Street—Fifth Avenue having led from the Washington Arch in Washington Square, nearly a mile to the south, then running straight to the Harlem River, over some seven miles,—continues to 33rd Street, crosses Sixth Avenue at a sharp angle, and at one of the busiest parts of the city : this being the terminal for the Hudson tubes and the location of many of the big department stores and hotels. Now expanded to a width appropriate to its name, Broadway crosses Seventh Avenue at 43rd Street, and continues to Central Park, which section between is that known the world over as the Great White Way. From 59th Street, Broadway and Eighth Avenue combine to form Columbus Circle at the entrance to Central Park. Leaving the Park, this thoroughfare retains its characteristic diagonal course, bears east at 78th Street, then runs with varying changes of direction until it crosses the Harlem River at Kingsbridge, to the Bronx, and travels along the west edge of Van Courtland Park to its terminus.

The eight-mile Flatbush Avenue, from East River to Jamaica Bay, is worth visiting. The skyscrapers dominating the New York skyline are too numerous for individual selection, but prominent among these are the Empire State building at 34th Street and Fifth Avenue, the Chrysler building at 42nd Street, Manhattan building at 40 Wall Street, whilst the area around the junction of 42nd Street with Broadway and in the vicinity of Grand Central Station, is one where many imposing skyscrapers can be seen to advantage.

Buildings commendable for their architectural excellence are the superb New York Public Library, the Customs House, Produce Exchange, National City Bank, Stock Exchange, and the City Hall, which is a fine specimen of 19th century design in marble. The Hall of Records and the Woolworth building could also be included in this category. The Morgan Library in 36th Street is of white marble, in classic style, and one of the best examples in the city. In the upper section of the city are such buildings as the American Museum of Natural History, Metropolitan Museum of Art, Cathedral of St. John, and the Columbus University Library.

There are many parks, the largest single area being Central Park, between Fifth and Eighth Avenues. In the Bronx, there is Pelham Park, with no less than 1,756 acres and eight miles of water frontage. Important monuments include Grant's Tomb, on Riverside Drive, the Obelisk, in Central Park, the Washington Arch, Maine Memorial, at the south-west entrance to Central Park, and the equestrian statue of Joan of Arc, also in Riverside Drive, to which, of course, is added the Statue of Liberty. Sightseeing by members and ladies will conclude at the Observatory on Empire State Building.

Joint Meeting of British and American Institutes

During the morning of October 3 the programme includes visits to Bell Telephone Laboratories Inc., or to the Police Headquarters in New York City. At 12-30 p.m. there will be a private meeting of the Councils of the two British Institutes in the Perroquet Room of the Waldorf-Astoria, and at 1-30 p.m. members and ladies will inspect the Engineering Societies Building, the address of which is 29 West 39th Street. This building is the headquarters of a number of important technical institutions, and includes in addition to their offices, an auditorium, lecture rooms, club premises, and a Joint Engineering Societies' Library. The joint meeting of both British Institutes with the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers will commence at 2-30 p.m. in the Auditorium of the Engineering Societies' Building.

This meeting will be under joint chairmen, Mr. T. M. Girdler, President of the American Iron and Steel Institute, and Mr. D. C. Jackling, President of the American Institute of Mining and Metallurgical Engineers, who will extend a welcome on behalf of their respective Institutes, which will be replied to by the Rt. Hon. the Earl of Dudley and Dr. C. H. Desch, Presidents of the British Iron and Steel Institute and Institute of Metals respectively. The following papers will subsequently be presented —

"Recent Developments in the American Iron and Steel Industry," by C. E. Williams, of the Battelle Memorial Institute.

"The Development of Continuous Strip Mills," by D. Eppelsheimer, Jr., of American Rolling Mill Co.

"Research and Development in the American Non-Ferrous Metal Industry," by Prof. C. H. Mathewson, of Yale University.

Technical Sessions

The following morning two technical sessions will be held. One in the Astor Gallery at the Waldorf-Astoria, with the Earl of Dudley as chairman, will comprise members of the British Iron and Steel Institute, with those of the American Iron and Steel Institute and the Iron and Steel Division of the American Institute of Mining and Metallurgical Engineers, at which the following papers will be presented :—

"American Electric Furnace Practice," by W. M. Farnsworth and E. R. Johnson.

"Electric Furnaces in European Steelworks," by D. F. Campbell.

"Grain Size and Hardenability in Steels to be Heat-treated," by E. C. Bain.

"Modern Rolling Mill Practice in America" (exclusive of continuous strip and sheet mills), by Quincy Bent.

The other meeting, held at the same time, but in the Jade Room at the Waldorf-Astoria, with Dr. C. H. Desch as chairman, will comprise members of the Institute of Metals with those of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers. At this meeting the following papers will be presented :—

"Some Characteristics of Copper-Aluminium Alloys made from Aluminium of Very High Purity," by Marie L. V. Gayler.

Main entrance to the Research Laboratories of Aluminum Company of America.

One of the testing laboratories of Bayonne Research Laboratory of the International Nickel Company, Inc.

The Bell Laboratories in New York.

"Oxidation-Resistance in Copper Alloys," by L. E. Price and G. J. Thomas.

"The Tarnishing of Silver and Silver Alloys and Its Prevention," by L. E. Price and G. J. Thomas.

"An X-ray Study of Dental Amalgams," by A. R. Troiano.

At each of these meetings the papers will be presented in abstract in order to permit time for some discussion.

Various alternative excursions are arranged for the afternoon, including a visit to A. Baker and Co., Bell Telephone Laboratories, International Nickel Co Research Laboratories at Bayonne, N.J., United States Steel Corporation Research Laboratories at Kearny, N.J., and a sightseeing excursion in New York City and district.

THE UNITED STATES STEEL CORPORATION

THE United States Steel Corporation is a very large organisation which operates, through its subsidiary companies, about 100 blast-furnaces, nearly 400 open-hearth and electric steel furnaces, over 20 basic converters, and about 500 rolling mills. It owns practically all the stock of such companies as Carnegie-Illinois Corporation, Federal Shipbuilding Co., Minnesota Steel Co., Illinois Steel Co., Lorain Steel Co., Canadian Steel Corporation, Ltd., National Tube Co., American Steel and Wire Co., American Sheet and Tinplate Co., Canadian Bridge Co., Union Steel Co., American Bridge Co., and many other companies, which include coal and iron ore mines, natural gas properties, railways, etc. The output of this Corporation is tremendous —in round figures, it may be given roughly as 20 million tons of iron, manganese and other ores; 12 million tons of limestone; 25 million tons of coal; 13 million tons of coke; 13 million tons of pig-iron, speigel, and ferro-manganese; 18 million tons of steel ingots and castings; 12 million tons of finished products; about 65,000 tons of zinc; and about 25,000 tons of sulphate of iron.

The research laboratories of this Corporation are very extensive, and particularly well equipped, and should prove especially interesting to those of the members who are engaged on investigations in ferrous metallurgy. Some

of the subsidiary companies to be visited are briefly referred to in a subsequent section.

For those members and guests returning to Europe in R.M.S. *Queen Mary* on October 6, arrangements have been made to participate in excursions on October 5, planned in Section III.

Section III—Tour in United States of America

Including Washington, Pittsburgh, Cleveland and Detroit

IN this section two alternative programmes have been prepared, and the party will comprise two groups. The programme for one includes visits to a large number of iron and steel works, while the other programme is of predominantly non-ferrous interest. Part of the programme is the same for each group. The complete tour in this section extends from October 5 to 18, inclusive.

Members of the ferrous group may visit the Thomas A. Edison Plant at West Orange, Bell Telephone Laboratories, International Nickel Co.'s Research Laboratories at Bayonne, or United States Steel Corporation Research Laboratories during the morning of October 5. This group are due in Washington in the evening of the same day. The following morning a visit to the Sparrows Point plant of Bethlehem Steel Co., near Baltimore, is planned.

These are very large works, and stated to be the largest steel mills located on tide-water. It has a fully equipped blast-furnace plant, with its own ore-unloading docks and coke-oven plant, the latter with its by-product department. The steel-making plant is extensive, comprising basic open-hearth furnaces, Bessemer converters, and metal mixers of large capacity. The mill plant includes blooming and slabbing mills, rail, billet, skelp and bar mills, continuous sheet and strip mills, new continuous rod mills, universal and sheared plate mills, continuous wire-drawing machines, etc.

Members may continue their visit to the works of the Bethlehem Steel Co. during the afternoon or visit Rustless Iron and Steel Corporation. Those not wishing to visit these plants will be able to join a sightseeing drive through Washington.

INTERNATIONAL NICKEL CO. INC.

THE Bayonne Laboratory is situated on about two and one-half acres of land at Bayonne, New Jersey, which is about seven miles from New York. It can be reached by the Central Railroad of New Jersey, and is only a few minutes' walk from the West Eighth Street Station of that line.

Started in 1924 with a staff of three, the Laboratory moved to new premises in 1931, and now consists of a group of buildings all of which are devoted to research by the full-time of its staff, which now totals 65 members. Its work on metallurgy and metallography embraces the properties of nickel and its alloys, steel, cast iron, the platinum group metals, Monel metal, and non-ferrous foundry alloys; and sections are devoted to welding, electroplating, corrosion, and analytical investigations. The Laboratory contains much of the familiar modern metallurgical equipment, and, in addition, a number of specialised types of apparatus designed and built in the instrument shop of the Laboratory.

Washington

The capital of the United States lies on the Potomac River, about 100 miles from its mouth, and 226 miles from New York, and more than 3,000 miles from San Francisco. The Capitol rises on a commanding position high on the eastern section of the city, and to north and south of that fine building are impressive buildings of white marble, a block to the eastward is the Library of Congress, and a mile to the west is White House, the latter being flanked on the east by the Treasury of the U.S. and on the west by the State, War and Navy buildings. The Washington Monument and Lincoln Monument will also attract the attention of visitors.

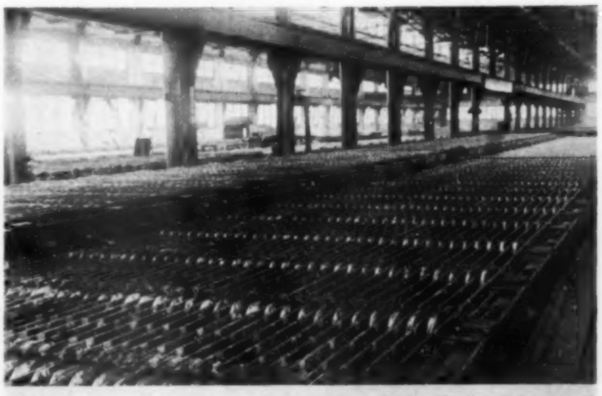
Washington is beautifully laid out. The narrowest street is 60 ft. wide, and the widest is 160 ft., all streets being distinctive also for their finish and tree bordering. Probably the widest and most beautiful thoroughfare is 16th Street, and there is an aggregate of 600 miles of street trees. Visitors should note the scientific layout of the town, and the park system, this possessing unique features. There is a 1,610-acre tract of great beauty lying to the west of the city, and known as Rock Creek Park, a zoological park, the Potomac Park, which borders the river from Georgetown to the eastern branch, and the Mall, which contains 306 acres and runs out and emerges from the 50-acre space surrounding the Capitol.

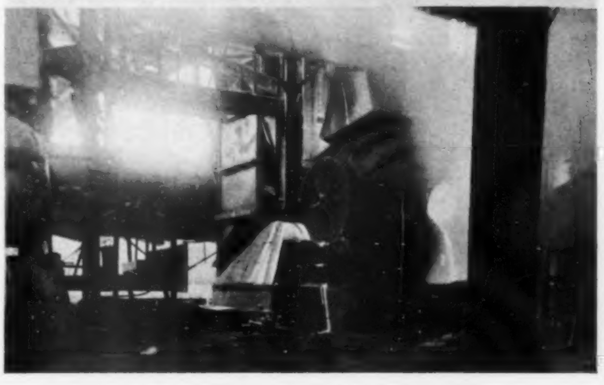
On October 7 arrangements are made for a drive to Annapolis, capital of Maryland, to visit United States Naval Academy. Alternative visits may be made to United States Navy Yard, Naval Observatory, Geophysical Laboratory or Bureau of Printing and Engraving during the morning, and the Bureau of Standards, Federal Bureau of Investigation or Smithsonian Institution during the afternoon.

Non-Ferrous Group

In this group alternative all-day excursions are arranged for October 5, which include visits to Perth Amboy Refinery of the American Smelting and Refining Co. at Baker, N.J., and Raritan Copper Works of Anaconda Copper Co., at Perth Amboy, N.J., and Carteret Copper Refinery of American Metal Co., at Carteret, N.J. A party

General view of electrolytic copper refinery and, below, skimming slag from a copper converter at works of United States Metals Refining Company.





Some examples of silverware produced in one of the many factories of the International Silver Company.

will visit the plant and laboratories of the New Jersey Zinc Co. The latter company, whose works at Palmerston, Philadelphia, will be visited, have mines in Sussex County, New Jersey, and control the Empire Zinc Company of Colorado, the Bertha Mineral Company, the New Jersey Zinc Company of Philadelphia, the Mineral Point Zinc Company, and the Empire Zinc Company of Missouri.

BELL TELEPHONE LABORATORIES

THE parent company of the Bell Telephone System has maintained a laboratory ever since the days when Alexander Graham Bell carried out experiments in a corner of a Boston workshop. As the system and its manufacturing companies grew, the number of laboratories was increased until the magnitude of the work handled became so great that a corporation devoted solely to research and development became necessary. Further centralisation was accomplished in 1934, and all activities are now carried on under the corporate name of Bell Telephone Laboratories Inc.

The diversity of interests, of equipment, and particularly of testing methods, will provide much of interest to members when they visit these laboratories. The systems for electrical communication are wire and radio; and the information to be transmitted may be in the form of speech, tele-typed letters, telegraphic codes, or pictorial details. No piece of apparatus is too small for development work; all physical and chemical characteristics must be ascertained and new materials analysed. New alloys and compounds must be invented or developed, new methods and processes must be devised.

A brief summary of some of the work undertaken in the laboratories will give an indication of the interesting activities which will be seen during the visit.

The ordinary telephone transmitter contains a small button of carbon grains, which are subjected to varying compression by the sound wave, and the current through the button undergoes corresponding variation. There should be no other variation in the current, but some exists, and makes itself heard in the receiver as "carbon noise." Transmitters are tested individually in a suspended drum, which protects them from vibration.

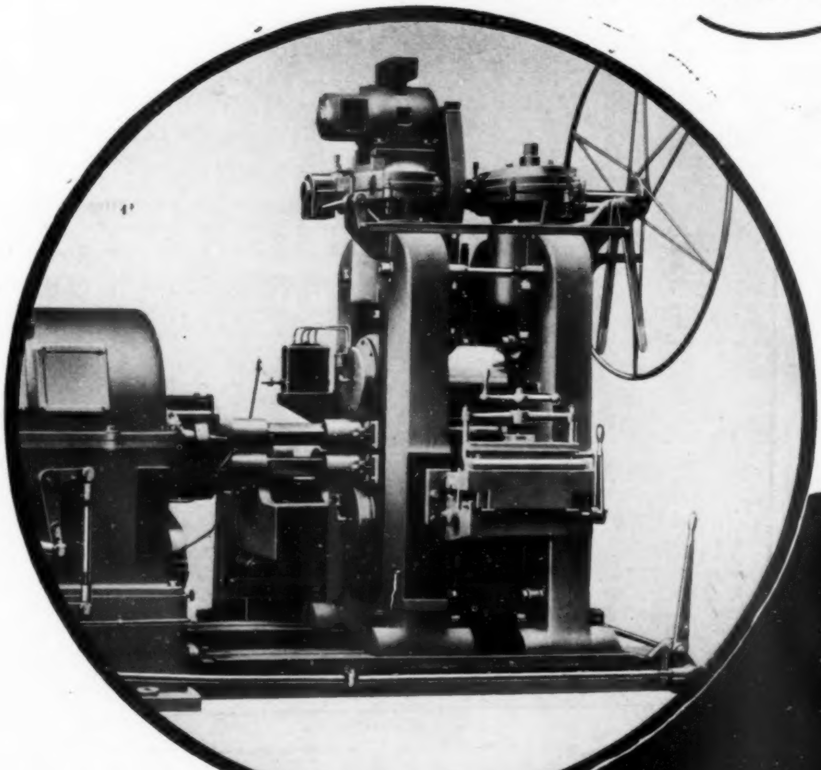
A new type of equipment is being developed for switching dialled telephone calls, each switch having an assembly of contacts interconnected so that every one of ten incoming paths can be switched to any of 20 outgoing paths.

The "carrier-current" system is most interesting, and these systems are assemblies of terminal apparatus which permit a single pair of conductors to transmit simultaneously, and without mutual interference, several different messages, the principle being that each message is "carried" by an alternating current of distinctive frequency. In the multi-channel operation of a toll line in the United States the ordinary telephone current is not transmitted but is used to modulate a carrier current and several modulated carrier currents flow at the same time over that line. At the far terminal these currents are separated by electric filters, and from each is obtained, by demodulation, a current identical to the original telephone current, and these are then directed over separate lines to their particular destinations. Essential parts of the systems are the electric filter and vacuum valve.

A very interesting piece of laboratory equipment is a ballistic galvanometer, arranged for the measurement of the response of magnetic materials to very small magnetising forces. To eliminate the damping effect of the air the galvanometer coil, which is subjected to successive impulses, is suspended in a highly evacuated jar. Very delicate measurement is needed for detection of what happens in a carbon-button transmitter. In one instrument the electrical contact of two particles of carbon can be studied in such delicate conditions that displacement can be measured to about four thousandths of a millionth part of an inch—about the diameter of a hydrogen atom,—and the force operating upon them can be measured to two ten-millionths of an ounce. Micro-analysis equipment is used in other directions, as for examination of specks of dirt on the minute contact-metal tips in relays.

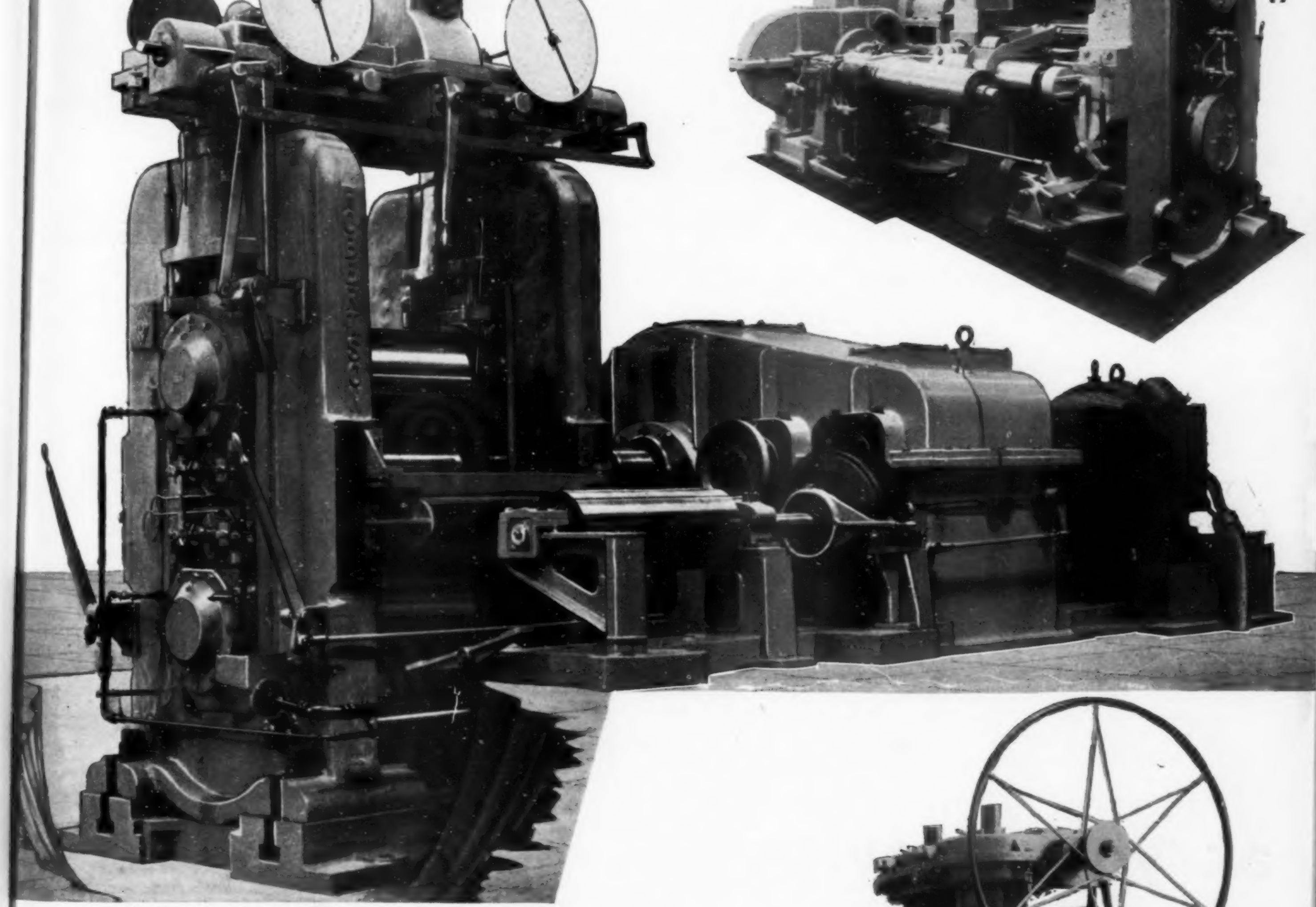
Photoelectric cells were used in the first commercial high-quality transmission of pictures, and other cells were designed to respond to the variations in photographic density of the sound track of a motion-picture film. The photoelectric cell is a vacuum valve containing two electrodes, one of which releases electrons in response to illumination, these electrons then being drawn across the valve to the other electrode, forming a current of an intensity proportional to that of the illumination. As is well known, many problems of surface chemistry, and of corrosion of metals, are being studied by electron-diffusion equipment, and in the Bell Laboratories there is an electronic department where the investigation of the invisible constitution of matter is being developed. Just as X-rays give information on the crystalline structure of metals and their atomic arrangement, so by the use of a stream of electrons can information be obtained as to the details of thin foils and of very thin layers upon surfaces.

Much interest will naturally be centred upon the metallurgical laboratory, with its equipment for uniform heat-treatment of large batches of material; whilst welding practice can be seen in the engineering shops of the laboratory. Magnetic materials play an important part, and such materials have been the subject of continuous research, as a result of which several new alloys have been developed. Possibly the most noteworthy are permalloy and perminvar, the first of which permitted considerable improvements in loading coils, whilst further reduction of size and cost

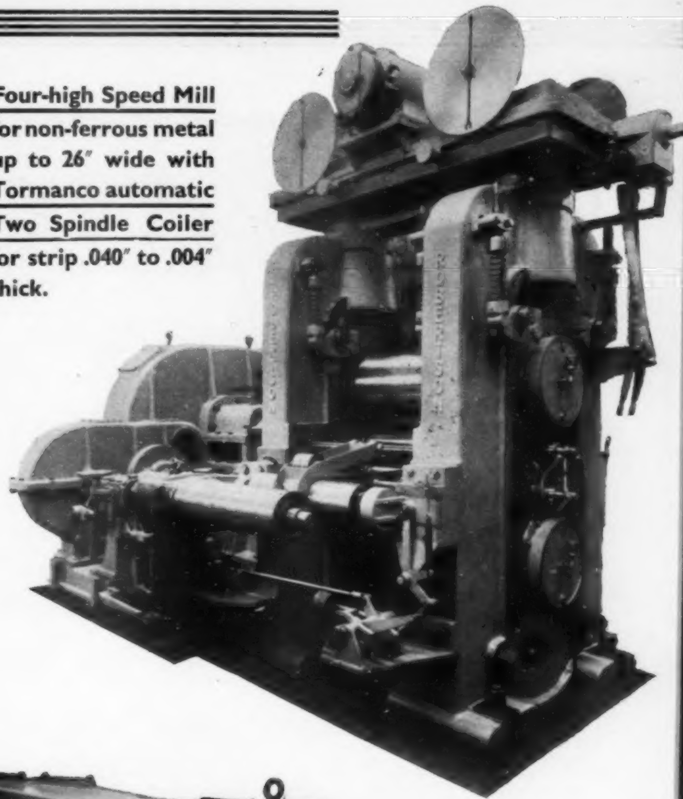


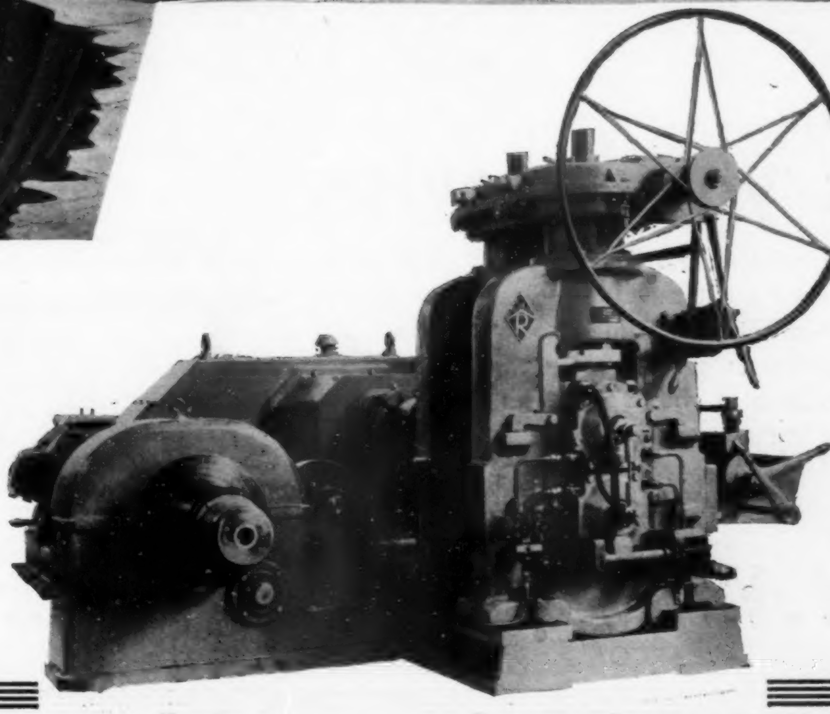
FOUR-HIGH COLD ROLLING MILL FOR STRIP **and sheet in stainless and other qualities of steel.**

WITH PATENT 'FLOOD' LUBRICATION bearings for Support Rolls giving MAXIMUM RIGIDITY AND STRENGTH WITH THE HIGHEST POSSIBLE EFFICIENCY.



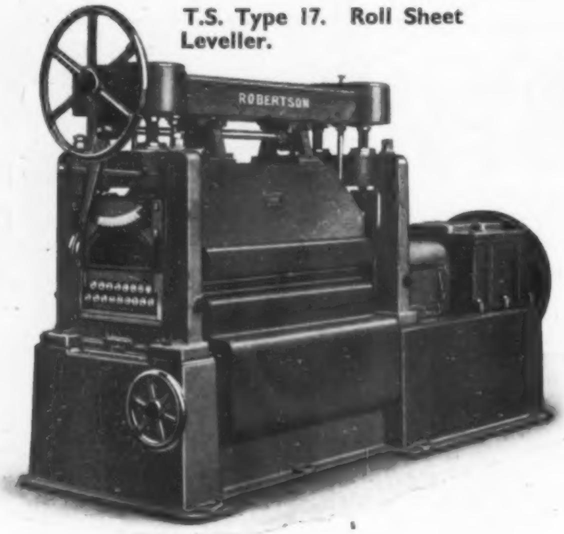
Four-high Speed Mill for non-ferrous metal up to 26" wide with Tormanco automatic Two Spindle Coiler for strip .040" to .004" thick.



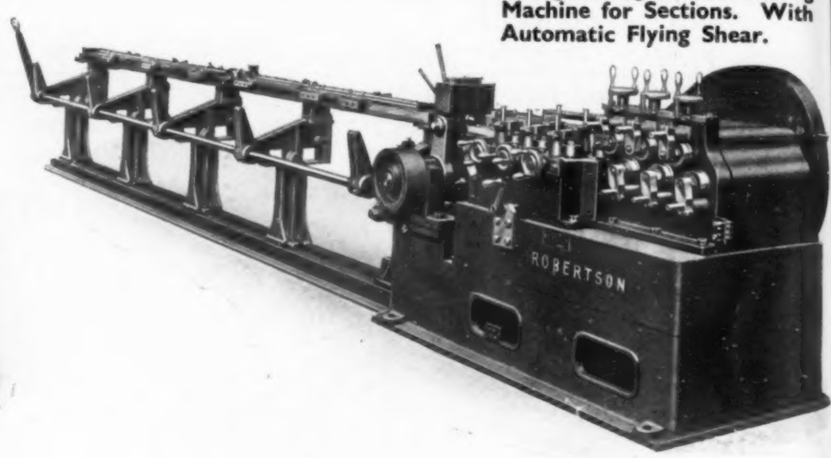


Standard Two-high Strip Mill for high speed Rolling of steel and non-ferrous metal strip with patent 'Flood' lubrication roll bearings.

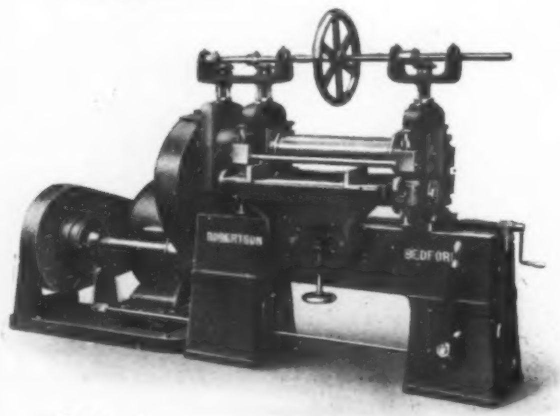
T.S. Type 17. Roll Sheet Leveller.



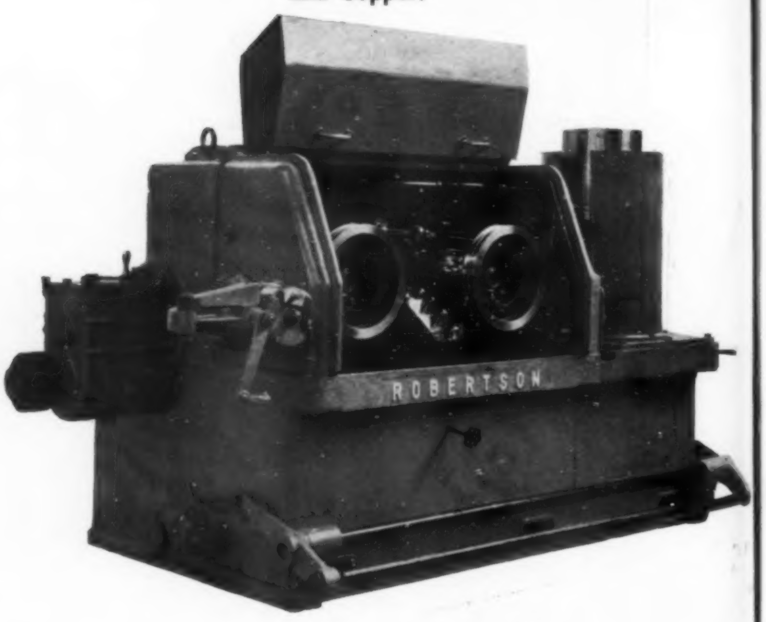
Straightening and Shearing Machine for Sections. With Automatic Flying Shear.



"G" Type Gang Slitting Machine Machine



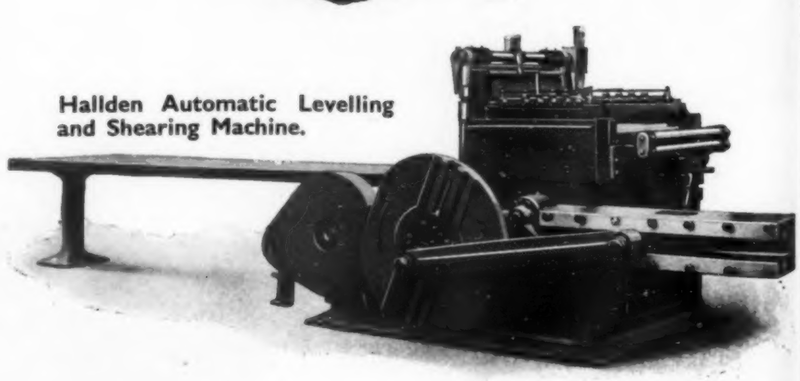
High Speed Multiple Die Wire Drawing Machine Type 11H. For Bronze, Brass and Copper.



at your service

The cumulative knowledge amassed in 30 years' experience; extensive experiments to achieve maximum efficiency at high working speeds; and stringent tests, enable us to proffer our advice in the solution of your problems relative to cold-rolling and auxiliary machinery.

Hallden Automatic Levelling and Shearing Machine.



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A general view of the Huntington works of the International Nickel Company, Inc.

Pouring Monel from a 15-ton Moore Lectromelt electric furnace at the Huntington plant.

have followed the later developments of permalloys. Hydrogenised iron is used, this having remarkable permeability and proportionate ease of magnetisation.

Finally, mention should be made of "Oscar." This is a semi-lay figure, with ears of special design of telephone transmitters, capable of faithful conversion into electrical current of any sounds which could be detected by human ears. These currents can be measured and analysed to determine quantitatively exactly what a human being would hear if in "Oscar's" place. He has played an important part as a laboratory assistant for many years.

UNITED STATES METALS REFINING CO.

THE plant of the United States Metals Refining Co. at Carteret, New Jersey, was founded in 1902 as an electrolytic copper refinery, and had an initial capacity of 800 tons a month. This production has been increased from year to year until it reached its present maximum of 240,000 tons annually. Blast-furnace smelting of copper ores was started in 1907, and a reverberatory furnace for smelting concentrates was put into operation in 1924. The present output of the smelter mill is in the region of 6,000 tons of blister copper a month, but this is contingent upon availability of suitable raw materials. A white-metal smelter and an electrolytic solder refinery were put into operation in 1928, and a lead smelter and refinery was added in 1931.

The present output capacity of the plant includes the following products in commercial quantities: Vertically-cast copper shapes of the company's brand, a second brand of copper shapes, oxygen-free high-conductivity copper shapes, cathodes, copper powder, gold in bar and powder, silver, also in bar and powder, platinum, palladium, iridium, rhodium, ruthenium, all grades of solder, both desilverised and antimonial lead, selenium in cake, stick and powder, tellurium in cake, stick or powder, and nickel sulphate.

The smelter is a pulverised coal-fired reverberatory furnace producing matte, and two blast-furnaces for producing "black copper," both of which products are blown to blister copper in two Pierce-Smith converters. The blister copper is cast in moulds and taken to the copper refinery, where it is blended with blister (from other smelters) and with suitable grades of scrap copper and melted into anodes, four pulverised coal-fired reverberatory furnaces being used. The anodes then pass to a multiple system electrolytic refinery, which has a production capacity of 18,000 tons of cathodes monthly, and from here the cathodes are transferred to "wire-bar" furnaces—also fired by pulverised coal,—to be melted down and cast into vertically-cast and horizontally-cast copper shapes. A large number of cathodes are diverted to that division of the works producing oxygen-free high-conductivity copper.

There is also a modern silver refinery, where the electrolytic slimes containing the metal from the copper cycle are treated, along with any slimes or residues sent in from outside sources; the principal products of this refinery being commercial bar gold, silver, and the other precious metals usually found associated.

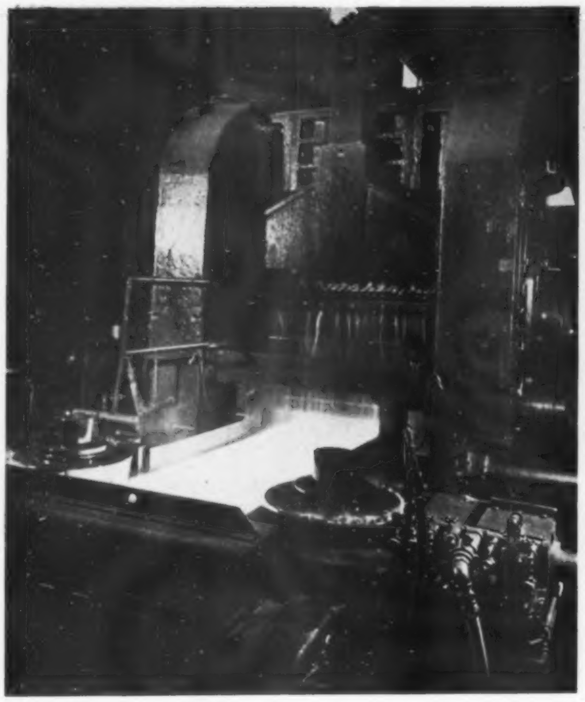
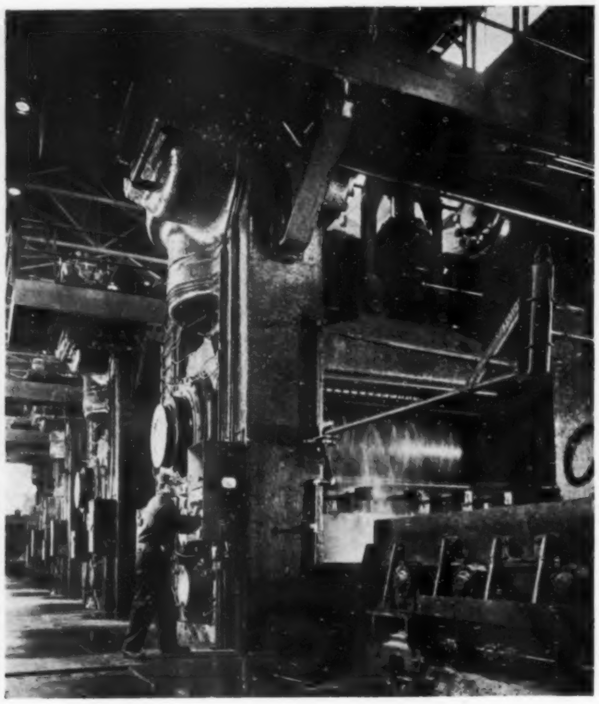
The lead and white-metal divisions are also equipped with blast and reverberatory furnaces for smelting ores and dross, with refinery equipment for purification of the blast furnace crude bullion and such other bullion and metallic scrap which might be shipped in for refining. In addition to this, the white-metal unit has an electrolytic refinery for the further purification of solder metal for special purposes, where ordinary solder is not adaptable. When desirable, in specified cases, virgin metals are used in the process.

An interesting point is that this company is one of the largest, if not the largest, producers of powdered copper in the world, producing copper in this form to specification for application in porous bearings and in the paint trade, with a monthly output of 300 tons.

The company is a subsidiary of the American Metal Co., and its location at Carteret gives it favourable transport facilities. It is about 20 miles south of New York City, and has access by road, by rail via the Central Railroad of New Jersey, and by water via Staten Island Sound. Both incoming raw materials and outgoing finished products are transported mainly by water, there being deep water available for ocean-going shipping, and being close enough to New York Harbour for barge shipment to be economic.

The United States Metals Refining Co. operates on a toll basis, or what is known as custom smelting. This policy means that miscellaneous ores and concentrates from all parts of the world are shipped to Carteret and are processed with scrap copper to blister copper; this applying also to blister, slimes, and residues for the silver refinery, and bullion and scrap shipped to the lead and white metal divisions on a toll basis from other smelters.

In 1936 the parent company produced 121,767 tons of copper, 78,031 tons of lead, and 43,491 tons of zinc. Its solder output in that year was 6,127 tons, and of sulphuric acid 102,368 tons. It produced 742,256 oz. of gold, 58,622,925 oz. of silver, 2,813 oz. of platinum, and 698 oz. of palladium: all interesting figures.

The four-high roughing stand and one of the four-high finishing stands forming part of the 100-in. semi-continuous mill at the Homestead works of Carnegie-Illinois Corporation. Note the vertical rolls in the foreground at the left, these are for edging the slabs.

THE RARITAN COPPER WORKS

IN the early nineties the New England Electrolytic Copper Company was operating at Central Falls, Rhode Island, one of the pioneer refineries of the United States, with a yearly capacity of about 15,000 tons. With the development of the copper industry, it was decided for economic reasons to erect a new and much larger plant at Perth Amboy, New Jersey. In 1898 ground was broken for the construction of the Raritan Copper Works, and in March, 1899, production of copper was started in the new plant and the old refinery at Central Falls dismantled.

The refinery capacity of the new plant was approximately 60,000 tons of copper yearly. There were four 50-ton anode furnaces, and nine cathode furnaces, five of 50-ton and four of 25-ton capacity. The 50-ton furnaces were at that time considered large furnaces, and it was thought that the economic limit as to size had been reached. To-day, however, modern furnaces have a capacity ranging from 275 to 375 tons, a wonderful tribute to the development of the copper industry.

Of the original plant little remains, the original buildings have all been rebuilt or remodelled on a larger scale. The equipment, boilers, engines, generators, etc., are continually changing as new and more efficient machinery is developed. The growth of the plant is indicated by its refining capacity, thus in 1899, when the new plant was started, the monthly capacity of 5,000 tons was developed to 6,000 tons. In 1906, with the construction of a new unit known as tank-house No. 2, the total capacity was raised to 12,500 tons of copper per month. The original 1899 plant was remodelled in 1911 and the total plant capacity raised to 16,500 tons of copper per month. An addition to tank-house No. 2 in 1916 increased the refining capacity of this tank-house and brought the total plant capacity up to 20,000 tons. The installation of new power equipment in 1927 further increased the capacity of the plant.

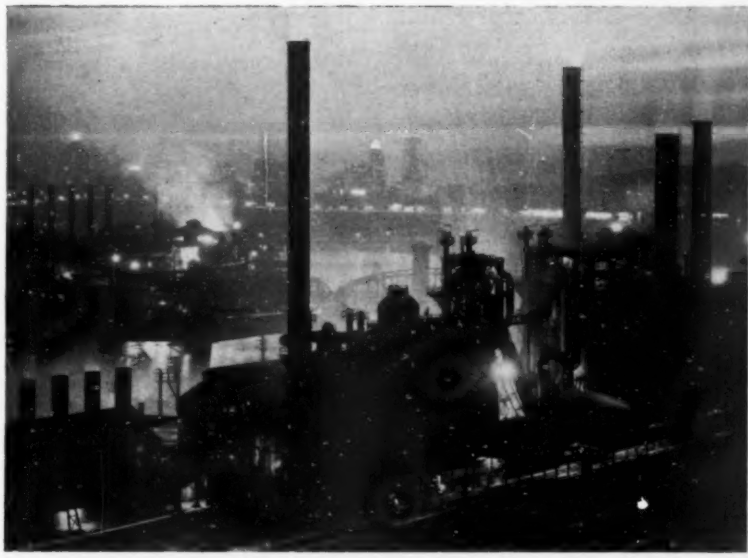
The plant of the Raritan Copper Works is situated 23 miles from New York, in the City of Perth Amboy, New Jersey, at the mouth of the Raritan River. In addition to its lighterage service to New York and the foreign steamship lines, the works has direct rail connection with the Pennsylvania, Central of New Jersey and Lehigh Valley Railroads. Shipping facilities for both incoming and outgoing materials are thus unexcelled.

The plant covers an area of 40 acres, and has a refining capacity of 22,500 tons of copper per month. The materials received from the smelters are all in the form of crude bullion, no ores being handled. The regular products of the plant include all commercial forms of refined copper, such as wire bars, ingots, ingot bars, square and round cakes, wedge-bars, slabs and billets. The by-products produced are refined silver and gold, platinum, palladium, selenium, tellurium, copper sulphate, and nickel sulphate.

Two grades of copper are produced—a high-grade electrolytic copper, possessing a high electrical conductivity which meets all requirements where copper of exceptional purity is desired; the second grade is an ingot copper which, while of too low conductivity for electrical uses, is an exceptionally satisfactory grade for casting purposes. Silver, gold, platinum, palladium, selenium, and tellurium are obtained from the anode slime resulting from the electrolytic treatment of the copper anodes. Silver and gold are ordinarily disposed of in the usual bar form; platinum and palladium as sponge. Selenium is produced in several different forms—viz., red amorphous form, as powder; vitreous form as powder, sticks, and ½ lb. cakes. Tellurium is made up into sticks, 1 lb. and 5 lb. cakes. A small proportion of nickel is found in most crude copper. In the process of electrolytic refining this accumulates in the electrolyte and is separated out and crystallised at this plant, as pure nickel sulphate ($NiSO_4 . {}_7H_2O$).

The anode furnace department in which the crude copper (blister copper) is cast into anodes contains four furnaces with a total capacity of over 1,000 tons of copper per day. Electrolytic refining of the anodes is carried on in two tank-houses. No. 1 tank-house contains 1,800 lead-lined tanks and has a capacity of about 11,500 tons of copper per month. No. 2 tank-house contains 1,656 tanks and has a monthly capacity of about 10,500 tons of cathode copper.

The cathode furnace department, which melts the refined cathode copper into the commercial shapes, consists



Three of the six blast furnaces in the Pittsburg works of Jones and Laughlin Steel Corporation. Beyond the company-owned railway bridge over the Monongahela river, connecting north- and south-side mills, can be seen the Bessemer converters and the tall office buildings.

Pushing coke from one of the battery of some 200 by-product coke ovens in the Jones and Laughlin Aliquippa works. Benzol, toluol, xylol, tar, tar acids and other by-products are produced by the Corporation.

of four furnaces with a total capacity of 1,000 tons of copper per day. Two smaller furnaces, with a total capacity of 110 tons of copper, are used for the manufacture of copper billets and special alloy copper shapes.

The electrolytic slime resulting from the electrolysis of the copper is worked up for silver, gold, and by-products by fire and electrolytic methods. Silver and gold are parted electrolytically by the Thum and Mœbius systems, the gold being refined by the Wohlwill process. The silver department refines the entire output of the precious metals produced by the Anaconda Copper Mining Company, and in addition to refining the slime from Raritan's tank-houses it also refines the slime from the Great Falls plant of the Anaconda Copper Mining Company and the dore silver from the International Lead Refining Company of East Chicago, Indiana.

The silver refinery has a capacity of 2,500,000 troy ounces of silver and 25,000 troy ounces of gold per month.

The Power Department was completely remodelled during 1926. Pulverised coal was substituted for fuel oil, three turbines with alternating current generators and four motor generator sets for supplying direct current were installed. The main boiler plant consists of three high-pressure 1,200 h.p. Stirling boilers, normally operating at 180 to 200 per cent. rating, at 385 lb. pressure, and delivering steam at 660° F. Four older Babcock and Wilcox boilers of 760 h.p. each are kept in reserve. The eight large copper furnaces are equipped with waste heat boilers, the steam from which is delivered to the main boiler plant and furnishes a material proportion of the steam requirements of the plant.

The new prime movers consist of three turbines, one of 2,970 k.w., and two of 4,750 k.w. each, generator rating, and all delivering power at 2,300 volts, 60 cycle. The turbines are arranged for condensing operations with bleeder points at 2 lb., 30 lb., and 165 lb. gauge pressure, to supply the steam required for the widely diversified plant operation. Four of the old type engine-driven direct current generators are kept for reserve purposes.

The Electrolytic Refining of Copper.

The electrolytic refining of copper may be divided into three stages—melting the blister copper and casting into anodes ready for the electrolytic tanks; electrolytic refining and obtaining cathode copper of 99·98% purity; melting of cathodes and casting the commercial shapes, such as wire-bars for wire mills, cakes for rolling mills, ingots for the brass and alloy manufacturers, billets for seamless tubing, etc.

The blister copper is delivered to the refinery in the form of slabs, weighing about 350 lb. These are melted in reverberatory furnaces, known as blister furnaces, of 250 to 400 tons capacity. In this melting process little refining is attempted, although some of the impurities are removed with the slag, and the sulphur is practically eliminated. The copper is cast into anodes, 37 in. × 28 in. × $1\frac{5}{8}$ in., weighing about 525 lb.

Of the usual impurities found in blister copper, the nickel, cobalt, iron, zinc and arsenic dissolve and foul the electrolyte, while the silver and gold, along with the other impurities remain in the slime, and drop to the bottom of the tank. Since the purity of the cathode copper depends on the purity of the electrolyte and the above impurities are constantly building up, it is necessary for all refineries to purify regularly a certain volume of their electrolyte.

At Raritan Copper Works the electrolyte is purified by a series of crystallisation, whereby the copper in the electrolyte is recovered as " commercial bluestone " and sold as such, the nickel, as a high-grade nickel sulphate (single salts) which finds a ready market, and the acid, after removal of the arsenic is used over again in the electrolyte. The slime is periodically pumped from the electrolytic tanks to the silver refinery, where, after an extended series of metallurgical processes, the silver and gold are recovered in a pure condition. The semi-rare metals, selenium and tellurium, are also recovered, but the commercial demand for tellurium is so small that only a fraction of the possible recovery is attempted. Small quantities of valuable platinum and palladium present in the slime are recovered. The lead, bismuth, and antimony are shipped as crude metal to lead smelters for further purification.

Naugatuck Valley

On October 6 and 7 the non-ferrous group make a visit to Naugatuck Valley, where visits to several works are arranged. One of these is the Ansonia Plant of American Brass Co., where copper and copper-alloys are manufactured in various forms. In the casting shop the various electric arc high-frequency and induction melting furnaces will attract particular attention. The hot and cold rolling of sheets and strips will be followed with interest, as also

A slab of steel entering the last of the four roughing stands in the hot mill of the new Jones and Laughlin 96-in. continuous strip mill. Another slab, just emerged from the roughing stand, is approaching the finishing train, consisting of six stands of rolls, where the final hot rolling will take place.

will be the hot rolling of wire rods, drawing of coarse and fine wire, and stranding of cable. Hot pressing and brass die-casting carried on at this plant are on an impressive scale. An alternative is provided by a visit to Bridgeport Brass Co.'s Plant at Bridgeport, Conn. Here particular interest will be taken in the hot rolling of rods for trolley wire, in the extrusion presses, tube-drawing equipment, and bright annealing furnaces.

The following day, October 7, there is a choice of several works' visits, including Scovill Manufacturing Co., where copper and copper-alloy sheet, strip, tube and extrusions are among the products. Members in this party will be interested in the casting shop, the four-high rolling mill, and a Steckel mill, rod extrusion press, a Schlœmann 1,100 tons vertical extrusion tube press, tube reducing machines, and various types of atmosphere controlled heat-treatment furnaces. Other parties will visit Chase Brass and Copper Co., Seymour Manufacturing Co., Waterbury Rolling Mills, or International Silver Co., at Meriden, Conn. These visits are made during the morning, and the group subsequently travels to Washington.

The two groups meet again on October 8 and visit Mt. Vernon, the home of George Washington, but on the following day one group is due to arrive in Pittsburgh, while an additional visit has been introduced to the Huntington Plant of the International Nickel Co., West Virginia. Others not joining these visits have a choice of various excursions on October 10 and travel to Pittsburgh overnight.

INTERNATIONAL SILVER COMPANY

ALTHOUGH this company has its main office in Meriden, it operates twelve factories located in New England and in Canada, manufacturing sterling and plated silverware. Some of these factories date back more than 90 years, at that time operating as individual and competitive companies, but were merged in 1898 to form the present company.

In addition to the main production of plated tableware spoons and forks, and cutlery, the company manufacture an extensive line of hollow-ware, dishes, platters, coffee and tea sets and other silver goods for table use or ornament. It is stated that this is the largest silverware company in the world.

The base metals used for plated ware are variously nickel-silver, copper or Britannia metal, and to fulfil its own needs the company operates both a casting shop and a rolling mill with a capacity of 500 tons a month of nickel-silver sheet and strip, and 50 tons a month of Britannia metal; placing the company in the position of one of the largest nickel-silver producers and, probably, the largest consumers of nickel-silver.

Visitors will note that new equipment has been installed in the steel-working divisions as well as in the non-ferrous and electroplating divisions; such machines as automatic buffing and plating machines being in general use, together with conveyer-type annealing and heat-treating furnaces, some with atmosphere control.

HUNTINGTON WORKS OF INTERNATIONAL NICKEL CO.

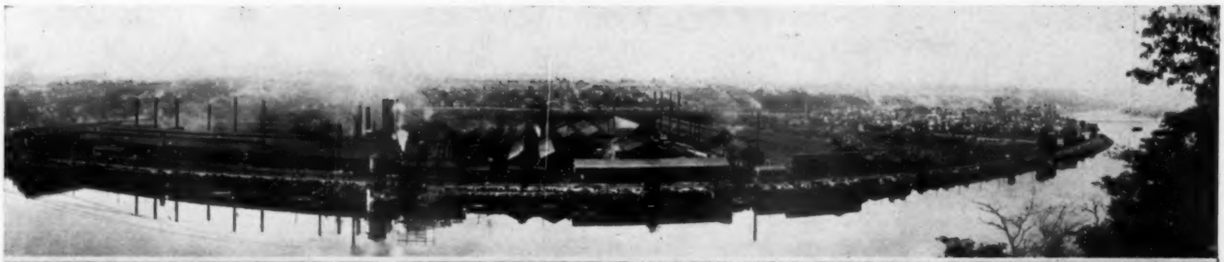
FOR no less than sixteen years the Huntington plant of the International Nickel Company of Canada, Ltd., has been the centre for rolling nickel and nickel alloys. The Huntington works is part of that international organisation, the International Nickel Company, Inc., which mined, refined, and marketed approximately 75,500 tons of nickel, 119,000 tons of copper, and 1,080 tons of silver, in addition to 220,980 oz. of platinum, in 1936.

Prior to 1922, the Nickel Company had a refinery but no rolling mills or other facilities of its own for producing its metals in sheet, strip, rod or wire form, and these had to be made in a steel mill on what is known as a toll basis. The final choice of Huntington as a site was influenced by such factors as appropriate labour supply, fuel supply—including natural gas, high-grade oil of low sulphur content, and high-grade bituminous steam and gas coals from local fields,—power supply, railway facilities, river and artesian water supply, equable climate, facilities for obtaining refractories, charcoal, castings and steel, and reasonable taxation.

The major production items at Huntington plant are rolled nickel, Monel, Inconel, and nickel anodes for plating purposes. The first three are produced in sheet, strip, and other commercial forms; rolled nickel is the solid and most pure form of the metal, being of 99.9% purity. Another development is that of " K " Monel, made of Monel with a small addition of aluminium. Raw materials for Huntington come from the Sudbury district of Canada, the largest source of nickel in the world; and Monel is found in an ore in which the two chief component elements are two-thirds nickel and one-third copper, and are found blended in that ratio naturally. The removal of rock and other waste matter is done before the Monel matte is shipped to Huntington; this matte, containing some 20% sulphur, being removed before Monel is ready for the refinery furnaces. Prior to reaching the plant, nickel is prepared by an electro-chemical operation, and is shipped, ready for the furnaces, as an electrolytic nickel.

The Monel matte in large irregular chunks is ground and passed to the calcination furnaces, 85 ft. long, where sulphur is eliminated and the matte is transformed to oxide, the furnace temperature being 2,300° F. The oxide from the furnace is mixed with charcoal, the metallic particles which result then go to the open-hearth furnaces, where further additions of charcoal are made and temperature is maintained at 2,750° F. Practically pure molten metal is taken to a 10-ton electric furnace for final refining at 2,800° F. Pure nickel is also processed in the open-hearth furnaces, and in the electric furnaces nickel and ferro-chrome are melted together to make Inconel. The three metals are then finished by very similar methods.

The molten metal is moulded into ingots, rough surfaces on the ingots are removed by milling machines and pneumatic chisels, and then pass to the hammer shop for forging into blooms. After removal of surface defects, the blooms are again heated and are passed through a 24-in.



Tapping a heat of stainless steel from a 25-ton electric furnace.

A slab approaching the first stand of the strip mill at Allegheny Steel Company.

(above) General view of the Brackenridge plant of Allegheny Steel Company.

rolling mill. Sheets may be subsequently hot- or cold-rolled, and strip is sent to a 20-in. mill for hot rolling, then to the strip mill for cold rolling. The plant includes mill equipment for producing rods, bars, wire and seamless tubing, the latter being sent in hot-rolled rod form for piercing by an outside mill, then returned to the Huntington works for cold drawing. Cold-drawn rods, bars, and wire are also produced. Cold-rolled or drawn material is annealed before rolling, and most products are given pickling, acid-bath cleansing, and polishing.

Pittsburgh

The great iron and steel town of Pittsburgh is regarded as the metropolis of the Ohio valley, and is the county seat of Allegheny County. Lying at the confluence of the Monongahela and Allegheny Rivers, it is traversed by those two rivers and by the Ohio, these giving the city a water frontage of more than 40 miles total. It is unlike many other American cities in that it is unusually hilly, the rivers flowing through a deep ravine which they have eroded, and the city being built on many hills on both sides of the water. Over 30 boroughs and townships have been absorbed into the city. The word " city " here is generally accepted as meaning the Point, a triangle formed by the junction of the two rivers.

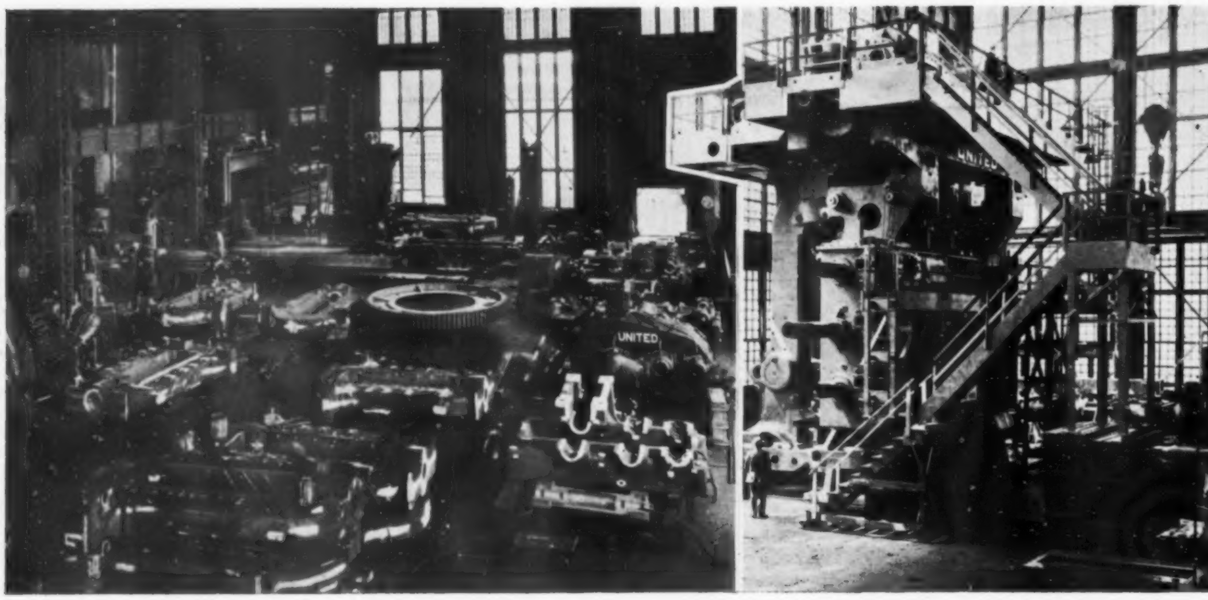
Pittsburgh is 290 miles from Washington, 431 from New York, 468 from Chicago, 150 from Cleveland, and 270 from Buffalo, N.Y. There is a magnificent system of boulevards, and, due to its geographical circumstances, probably more bridges and viaducts than in any other city in the world. As with so many other American cities, there is an extensive and attractive use of open spaces for providing parks. The Carnegie Institute and Library, the University of Pittsburgh, U.S. Bureau of Mines, the Carnegie Art Museum, are only a few of the places which should be visited in this interesting city.

In addition to its vast iron and steel interests, Pittsburgh is the seat of the aluminium industry in America. Glass-working is one of its well-known productions in enormous volume; the total of industries and products in this town assuming imposing proportions.

IRON AND STEEL WORKS VISITS

A COMPREHENSIVE range of visits to works in the Pittsburgh district is arranged for Oct. 10 to 12, covering four major classifications of operations—viz., coke and iron, iron and steel, steel finishing, and rolls and roll mill equipment. The visits include the Clairton Works, Homestead Steel Works, Edgar Thomson Works, Irvin Works, and Duquesne Works of Carnegie-Illinois Steel Corporation; Pittsburgh Rolls Corporation; Pittsburgh and Aliquippa Works of Jones and Laughlin Steel Corporation; Firth-Sterling Steel Co.; Mesta Machine Co.; McIntosh-Hemphill Co.; Brackenridge Works of Allegheny Steel Co.; United Engineering and Foundry Co.; Westinghouse Electric and Manufacturing Co.; National Tube Co.; Donora Works of American Steel and Wire Co.

Non-ferrous members will be interested in a visit to Aluminum Company of America, at New Kensington; while considerable scientific interest is attached to a visit to Mellon Institute for Industrial Research, where a film will be shown to illustrate some of the operations of the Aluminum Co. in the production of aluminium. Plans are also prepared for additional visits to plants in the Pittsburgh district, including A. M. Byers Co. at Ambridge, where the Aston process for producing wrought iron is



General view of erecting floor and, right, erecting a 45 × 80-in. slabbing mill at the Youngstown plant of United Engineering and Foundry Company.

operated; Edgewater Steel Co. at Oakmont, where rolled steel wheels and locomotive tyres are made; Harbison-Walker Refractories Co.; Jessop Steel Co. at Washington, which specialises in alloy and tool steel; Pittsburgh Steel Co. at Allenport, where the plant includes automatic seamless tube mills; Spang-Chalfant, Inc. at Etna, specialising in electric-welded pipe; and Universal-Cyclops Steel Corporation at Bridgeville, where alloy and tool steels are manufactured.

THE ONE HUNDRED-INCH PLATE MILL OF THE CARNEGIE-ILLINOIS STEEL CORPORATION

A one hundred-inch semi-continuous plate mill at the Homestead works of the Carnegie-Illinois Steel Corporation, at Gary, Indiana, is claimed to be the largest steel mill in the world. This mill has some very interesting features, including a magazine feeder in the slab storage room. Stacks of slabs are lifted to roller tables which convey them to this magazine feeder, then bars on the feeder sweep off slabs and an electrically-operated pusher moves the slab forward into one of three furnaces of the gas-fired, continuous type. When the slab pushers operate, every slab in a line more than 80 ft. long is moved forward and a heated slab is ejected at the discharging end of one of the furnaces, each of which takes two lines of slabs. These furnaces are each capable of reheating 50 tons gross of cold slabs per hour.

A scale breaker, comprising a two-high non-reversing type with work rolls 36 in. by 100 in., driven by a 1,000-h.p. motor, is fitted with water jets which discharge under pressure of 1,000 lb. per sq. in. A broadside mill or turn-about moves the slab through an angle of 90°, then a pusher aligns the slab and passes it into the four-high non-reversing spreading stand with its 42 in. by 120 in. work rolls and 52 in. by 120 in. back-up rolls, and driven by a 4,500-h.p. motor. After passing through this spreader, the slab is again turned back to its lengthwise position, and moves forward on the table rollers to the slab squeezer, where a platen ho'ds the slab down in position, and flattens it, and two hydraulic 16-ft. heads move in from either side to parallel the edges.

The slab then comes to the reversing vertical edging stand, whose two vertical rolls true the edges of the slab just after it has passed through another water-pressure scale remover, and the slab enters the four-high reversing roughing stand, passing to and fro through this stand until the gauge has been reduced sufficiently for handling by the finishing stand. The roughing stand has work rolls 36 in. by 100 in., back-up rolls 54 in. by 100 in., and is driven by the largest motor in the mill, one of 7,000 h.p.

The plate is moved forward to the four finishing mills, these being massive four-high stands. Each of these four mills are similar, each has 5,000-h.p. motor, work rolls 27 in. by 100 in., and back-up rolls 54 in. by 100 in. The plate is then passed through a series of high-pressure water sprays, cooling being controlled to ensure a tight, uniform oxide coat on the finished plate.

When the plates have passed through the leveller, they are cooled over conveyer tables with offset spools extending for a quarter of a mile, to the crop shear, and then to the rotary side-trimming shear. Here the plate is taken by electro-magnets, those at one side centre the plate, and those on the other side travel with the plate through a part of the shearing operation, and are then synchronised with the speed of the shear. Plates then pass transversely to an ingenious end shear. This is operated on a rocking principle which eliminates the tendency of plates to bow under shearing effect, as the curved blade results in a clean and even cut without metal distortion.

The scrap from the ends of the plates is handled by another ingenious machine, in which blades come together in a cupping motion and chop up the scrap to let it fall into bins beneath.

Another conveyer takes the finished plate past an automatic weighing machine with an automatic scale and as many keys as an office adding machine, recording the weight of each plate and adding this weight to those previously weighed.

At the stacking bed mechanical arms lift the plate into position for stacking and enable the operator to select plates according to gauge, length and width. The plates pass through a final inspection, and are then lifted by overhead crane to railway trucks or whatever other means of transport is used for shipment to individual customers.

The capacity of this impressive mill is 729,000 gross tons a year, this output being based on a six-day week. Three slabs pass through the mill simultaneously, a slab leaving the last finishing stand every minute and a half. Plates rolled here are from 20 in. to 90 in. finished width, and from $\frac{3}{32}$ in. to $\frac{5}{8}$ in. thick. The equipment of the shear

Left.—Casting a large back-up roll at the Vandugrift plant.

Right.—Part of the roll lathe department at the Canton plant of the United Engineering and Foundry Company.

building comprises three roller levellers, one crop shear, one rotary shear, two 80-ton rocking shears, one normalising and annealing furnace, and two stacking beds.

Some idea of the size of this great mill can be gained from the fact that the weight of mill stands, levellers, shears, tables and transfers totals over 14,000 tons ; and this is the more impressive when it is stated that this tonnage is exclusive of electrical equipment.

JONES AND LAUGHLIN STEEL CORPORATION

THE Jones and Laughlin Steel Corporation, comprising the fourth largest steel producer in the United States, was founded in 1850. The original mills had a capacity of some 7 tons of iron a day, and the organisation has grown until its annual steel ingot capacity is 3,660,000 tons. This growth has been through expansion of trade and manufacturing facilities, without mergers.

The corporation controls its own sources of raw materials, bringing iron ore for the blast-furnaces from its own workings in the Lake Superior district and shipping this ore down the Great Lakes in the company's boats to ore docks along Lake Erie. It is then transhipped to the Pittsburgh and Aliquippa works by rail. In the same way, coal mines are operated in Pennsylvania and limestone quarries in West Virginia.

The production and processing of steel and steel products is carried out at the Pittsburgh and Aliquippa works. The Pittsburgh works, at Pittsburgh, Pennsylvania, comprise some 250 acres, and has approximately two miles of frontage on the north bank and one mile of frontage on the south bank of the Monongahela River, the plants being interconnected by a railway and bridge owned by a subsidiary company.

The works consist of a 360-oven by-product coke plant with an estimated annual capacity of 1,462,000 tons gross, and a by-product coke-recovery plant ; a group of six blast-furnaces, having an estimated annual capacity of 1,434,000 tons gross ; a Bessemer and open-hearth steel works, comprising two Bessemer converters, nine tilting and thirteen stationary open-hearth furnaces and three metal mixers, having a total annual steel ingot capacity estimated at 2,120,000 tons gross.

In the semi-finishing departments there are two blooming mills, two billet mills, and five bar mills. The finishing departments contain the 96-in. continuous strip-sheet mill, with facilities for producing hot- and cold-rolled strip, sheets, and allied products. This mill was completed in 1937 and has an estimated annual capacity of 720,000 tons gross, supplying various grades and finishes in coils and cut lengths, light plates, also coils for the Aliquippa works tin-plate department, and wide skelp for the tube mills at the Aliquippa works. This mill also includes galvanising and corrugating equipment for sheets, and pickling and annealing plant for all its products. Also in the finishing departments are two plate mills, two cold finishing bar departments, a tie-plate shop, a spike manufacturing plant, a structural steel fabricating shop, and a department for bending, shearing, and storing concrete reinforcement bars. In addition to the other necessary facilities for an integral steel works, there are iron, steel, and brass foundries.

The Aliquippa works are located at Aliquippa in Beaver County, Pennsylvania, and comprise approximately 475 acres of land, with some three and a half miles of frontage on the bank of the Ohio River, 19 miles from Pittsburgh. This works has a 203-oven by-product coke plant, whose estimated yearly capacity is 1,336,000 tons gross, a by-product recovery plant, a group of five blast-furnaces with an estimated annual capacity of 1,728,000 tons gross ; a Bessemer and open-hearth steel works, consisting of three Bessemer converters, four tilting and one stationary open-hearth furnace, and two metal mixers, the total estimated annual capacity of which are 1,540,000 tons gross. In reserve is a 326 rectangular oven coke plant, without facilities for the recovery of coke by-products, and with annual capacity estimated at 321,000 tons gross.

There is a blooming mill, a continuous billet mill, a continuous sheet-bar and skelp mill, a 10-in. skelp mill, two continuous wire rod mills, a 30-in. round mill, and a continuous 14-in. merchant mill. In the finishing departments there are also wire, nail and fence departments, with two galvanising units ; a tinplate division consisting of 24 hot mills, seven trains of cold finishing rolls, a four-high cold reducing mill, three temper mills, annealing furnaces, and 41 tinning stacks ; a tube mill consisting of two butt weld and three lap weld mills, three seamless pipe mills, two coupling shops, and two galvanising units. There are facilities for handling coal and ore ; boiler-house, electric generating and pumping plants, and laboratories.

The corporation recently erected a modern wire-rope plant at Muncy, in Lycoming County, Pennsylvania. The Pittsburgh and Aliquippa works are equipped to produce a very diverse range of steel products, catering for many requirements in agriculture, building construction, transport, motor, hardware, furniture, lumber, oil, and other industries. The proximity of the two works enables semi-finished materials to be transferred quickly and economically by rail or water from one works to the other for such finishing whenever such transfers are necessary or advisable.

A fleet of river boats and barges is maintained by the

corporation for the distribution of its finished products into the central, south, and south-west parts of the country served by the Ohio and Mississippi Rivers, which, with their tributaries, form a 6,000-mile network of navigable waterways.

ALLEGHENY STEEL CO.

WHEN the Allegheny concern was first organised in 1901, under the title of the Allegheny Steel and Iron Company, it possessed one open hearth furnace, one bar mill and four sheet mills. A plate mill and steel casting foundry were added in 1905, and other companies were acquired, together with their equipment, in succeeding years. The title of the Company was later changed to Allegheny Steel Company, and this was one of the first companies to roll strip in the United States. The main plant, at Brackenridge, Philadelphia, about 23 miles from Pittsburgh, had no facilities for rolling the narrower widths, so plant for this purpose was acquired at Leechburg, Pa., in 1936, giving the Company two manufacturing plants.

The Brackenridge works has an electric furnace department with monthly output of 8,000 tons—principally chromium, stainless and high-silicon steels. There are five 10-ton and two 25-ton arc furnaces. In the open-hearth department are 10 furnaces, all fired with natural gas, and having a total monthly capacity of 35,000 tons. Ingots from the electric and open-hearth furnaces are passed to the 34 soaking pits, 23 of which are constructed with regenerators and 11 with recuperators, the regenerative pits being fired with producer gas, and the recuperative type using natural gas. The blooming mill is of the reversing type, has rolls of 31 in. × 84 in., producing slabs from 3 in. × 5 in. to 2·5 in. × 32 in., and billets from 5·5 in. square to 10·5 in. square. In the 30-in. strip mill are three roughing stands and four 4-high finishing stands, and a flying shear that cuts strip from 7 ft. 6 in. to 30-ft. lengths at a speed of 950 ft. per minute. Mill capacity is 42,000 tons a month, supplying both section and coiled strip.

In the sheet-mill department are continuous-type furnaces heated by natural gas, four pack mills with automatic feed, four 2-high cold mills, two 2-high pack mills, and two 2-high stands for rolling alloy steel sheets, the latter four mills being in a separate division; total capacity is in the region of 18,000 tons a month.

A merchant mill produces flats, rounds, squares and angles, and these are annealed in five natural-gas-fired furnaces. Comprehensive finishing equipment is seen in this department.

Slabs from the blooming mill are cut by acetylene burner into suitable lengths for the plate mill, where there is a 3-high 110-in. mill, one regenerative and one non-regenerative furnace; the production limits being 94 in. wide, 30 ft. long—for the narrower widths and lighter gauges,—with minimum gauge of $\frac{3}{16}$ in. and maximum of 2·5 in. Tests are made for carbide precipitation on all stainless steel plate, which forms the bulk of the output, and the plates are shipped in waterproof paper wrappings.

A tube mill department with a monthly output of 2,000 tons of tubes from 2 in. to 7 in. outside diameter; a seamless tube division for alloy tubes from $\frac{1}{4}$ in. to 6·5 in., with monthly capacity of some 300 tons; iron and steel foundry departments, and lamination departments are other interesting and vital sections of this big works on the banks of the Allegheny river.

The Leechburg division of the Company has largely confined its operations to the production of strip ranging from $\frac{1}{2}$ in. to 24 in., the billets for which are produced at the Brackenridge mills, and then rolled on either a 16-in., a 12-in. or 9-in. mill. There is a stand of scale-breaking rolls for the largest mill, six pot annealing furnaces and one furnace for annealing strip as it is uncoiled; whilst for each mill there is pickling equipment.

The cold-rolling department is well furnished, for cold reduction of alloy steel strip eight Steckel mills are used, the strip from these mills being passed into two vertical electric furnaces, or four muffle gas-fired furnaces. Two electric- and one gas-fired furnace have been more recently installed for annealing high-silicon steel strip. Copper-coated steel is also produced. The total output of the plant in a normal year is about 250,000 tons of strip within the dimensions previously stated.

THE UNITED ENGINEERING AND FOUNDRY CO.

FOR many years this Company has concentrated on the development of machinery required for the production of sheets and tinplate by the hot- and cold-reduction strip rolling method as well as the auxiliary machinery required for the processing of strip. The Company has five production divisions which are located within a radius of 150 miles of Pittsburg, viz.: Frank Kneeland plant, Pittsburgh; Youngstown Plant, Ohio; Wooster plant, Ohio; all of which are machine divisions; Vandugrift plant, Pa., the steel castings division; and Canton plant, Ohio, the iron castings division.

The three machine divisions are so integrated that any type of rolling mill equipment may be produced completely in any one of the three shops, but the Youngstown, Ohio, division is the largest of the three and at that plant the larger mills and equipment are generally fabricated.

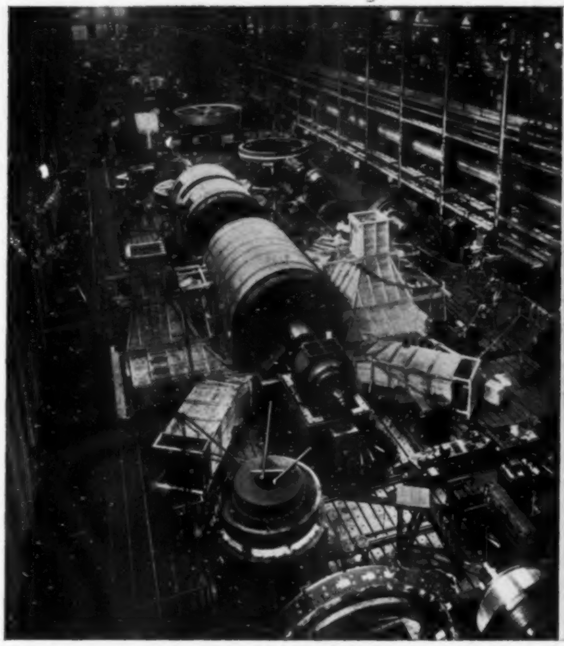
The Vandugrift steel foundry is one of the largest steel foundries in the United States. At this plant the Company's special cast-steel rolls are manufactured completely, as well as the mill housings and all other steel castings required for the manufacture of United products.

The Canton, Ohio, cast iron foundry specialises in many grades of iron castings for the manufacture of the Company's gold wabbler, green wabbler and yellow wabbler rolls and other general iron castings required in the manufacture of its products. Here, as well as at Vandugrift, rolls are finished, ready for installation in the mill.

This Company together with its associated companies, the Davy and United Engineering Company in England and the Dominion Engineering Works in Canada, is claimed to be the largest designer and manufacturer of rolling mills and rolls in the world. It is quite enviable of its record in the development of the continuous hot- and cold-strip mill. Not only was the first continuous strip mill built, engineered, designed and constructed by this Company but also the latest, which is the largest and fastest strip mill in the world. The first mill was a 42-in. hot-strip mill installed at the Butler, Pa., plant of the American Rolling Mill Company and the latest and largest of all is the 98-in. hot- and cold-strip mill installed at the Republic Steel Corporation's Corrigan-McKinney division, Cleveland, Ohio, described elsewhere in this issue, and which many members will take the opportunity of seeing in action.

It is noteworthy that out of thirty-two continuous hot-strip mills erected in the United States, England, Russia and Japan, eighteen were designed and built by this Company. Among these were the recent installations of Richard Thomas and Co. Ltd., Ebbw Vale, Mon., the Zaporojstal Steel Works, the Soviet Union, Nippon Seitetan, Japan; and numerous four-high reduction mills both in the United States and foreign countries.

The general offices of the Company are located in the First National Bank Buildings, Pittsburg. This building is a twenty-six storey skyscraper and the Company occupies the top six floors. Here are located the executive, sales, engineering, purchasing and accounting departments of the organisation. The engineering department alone employs over a hundred experienced engineers and draftsmen for the development of the modern rolling mill machinery, rolls, processing and shearing equipment. The Company offer the use of these offices to members as a meeting place and as an address where mail or cablegrams may be sent and held until called for. Members and



Testing two large 68,750 k.v.a. motor generators and, right, assembling motors at the East Pittsburgh plant of the Westinghouse Electric and Manufacturing Company.

guests of the Institutes will be welcomed at the general offices by Messrs. C. T. Ladd, President; K. C. Gardner and F. C. Biggart, Vice-Presidents; J. L. Young, manager of machinery sales; H. A. Houston, assistant to general manager; H. Magar, manager of roll sales; H. H. Talbot, senior engineer; and M. P. Sieger, chief engineer. Those who will be visiting various plants of the Company will be received by Messrs. C. W. Knotts, manager of the Youngstown division; J. Quinn, manager of the Canton Plant; A. C. Voelker, general superintendent of Frank Kneeland Plant; J. McCormick, general superintendent of Vandergrift Plant; and H. Kuthe, general superintendent of the Wooster Plant.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.

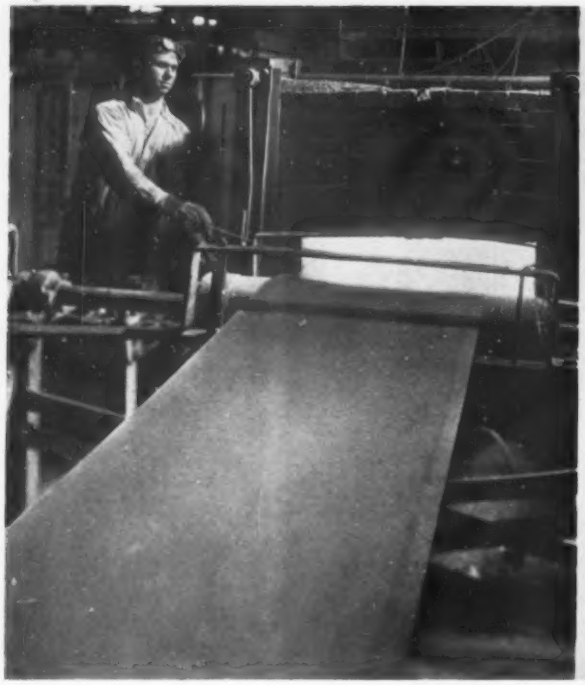
THE general headquarters and principal Westinghouse works which will be seen at East Pittsburgh, Pennsylvania, cover an area of 185 acres, and produce basic electrical equipment of all kinds. This includes generators, switchboards, switchgear and supervisory control equipment; more than 30,000 distinct sizes and types of motors; manual, semi-automatic and fully automatic controls of every sort; motor-generator sets, locomotives for the mining industry; electric welding apparatus; industrial heating equipment; motors and controls for electric locomotives; motors for tram cars; Diesel-electric generators; and Micarta, which is an insulation material developed by the company and used for both industrial and domestic purposes.

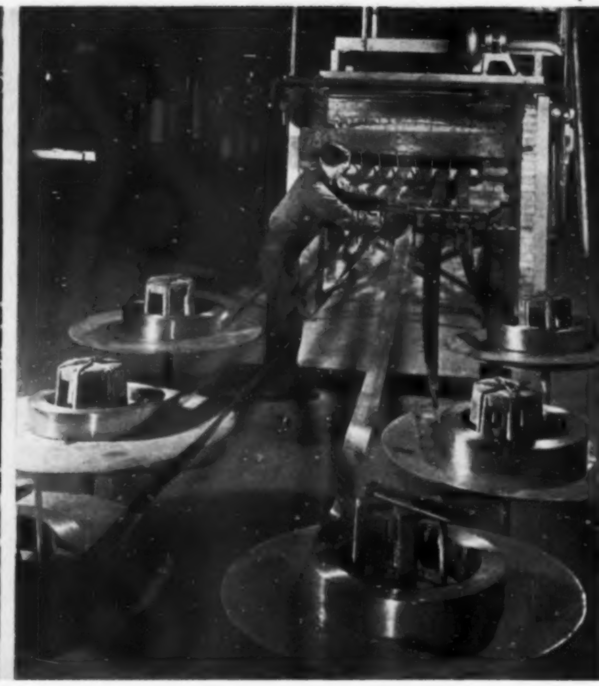
The two of the waterwheel generators for the Boulder Dam were the largest of their type ever built; the Boulder Dam water gates fabricated by electric welding; motors and controls for the Youngstown Sheet and Tube Company's new continuous hot strip mill, one of the highest powered in the industry; complete electrical equipment for the New York, New Haven and Hartford company's new streamline "Comet" train; and electric locomotives for the new Pennsylvania fleet operating between New York and Washington, are among recent outstanding achievements of the East Pittsburgh works.

It is significant to note that the Westinghouse Electric and Manufacturing Company exists to-day as one of the largest institutions in the world carrying the name of a single individual. Power and transport have much to thank George Westinghouse for. He made his first major contribution to transport by the invention of the air brake for steam railways, developed a complete automatic telephone exchange, designed high-speed steam engines, produced a system for transmitting and metering natural gas, and was one of the first to recognise the advantages of the steam turbine. It will be noted that all those major contributions to the active progress of science and invention during twenty-five years do not include electrical inventions and developments, and it is in this field that he is best known as a bold and greatly beneficial pioneer. It is considered that the greatest contribution made to the modern world by Westinghouse was the removal of the limitations of electric systems by the introduction of the alternating-current system, the most practical advantage of which is the facility of changing voltage or pressure, thereby making long-distance transmission of electric power practicable.

Landmarks in the history of the company are the acquisition of patents on a type of transformer which formed a vital link in the projected alternating current system in 1885; patenting of the oil immersed transformer in 1887; the introduction of the "toothed core" armature in 1889; origination of the rotary converter and the polyphase system of alternating current generation and distribution in 1892; installation of the first electric generating station at Niagara Falls in 1895; the introduction of the Parsons' steam turbine in 1899; electrification, for the first time, of the main rolls of a steel mill in 1905; electrification of an American railway in 1906; perfection of the harmonic wave analyser for study of alternating current phenomena in 1914; electrification of super-Dreadnoughts of the U.S. fleet in 1921 and 1923; and supply of the town of St. Louis with the largest planned street-lighting installation in the world in 1925.

Space does not allow enumeration of the many more achievements of this company, for not one year has passed, during the past fifty years, but that the Westinghouse have not made one, but generally several, contributions to progress and modernisation. For instance, the Virginian railway was electrified, placing in service the most powerful





Stainless steel strip leaving the delivery end of No. 1 annealing furnace and, right, narrow stainless strip entering annealing furnace at Cuyahoga works in Cleveland of American Steel and Wire Company, a subsidiary of United States Steel Corporation.

electric locomotives in the world, in 1925. Eleven years before that a system of gearless traction made high speeds possible for lift operation in skyscrapers; whilst in 1926 a quota control system for electric lifts made it possible to operate lifts in skyscrapers in batteries, and in 1933 the highest speed passenger lifts in the world were installed at the Rockefeller Centre, New York, these being capable of a speed of nearly 16 m.p.h. so that a passenger could be taken from the ground floor to the 65th storey in less than a minute.

Electric refrigerators, air-conditioning equipment, turbine generators, sodium lighting highway installations, vacuum tubes for control of industrial equipment, X-ray tubes, escalators, vacuum cleaners, cooking appliances, and a whole range of products for both industry and the home give evidence of the versatility of Westinghouse activities.

Assembly of large mill motors, testing of generators and motors, and various aspects of precision testing are sources of interest, and reveal some of the large scale operations that take place at the East Pittsburgh works.

AMERICAN STEEL AND WIRE COMPANY

THE Cuyahoga works of the American Steel and Wire Company is by far the largest of the Cleveland plants of the Company. Construction of the first units of this plant, consisting of a wire mill with cleaning, annealing and baking equipment, a bale-tie department and a hot mill, together with a small boiler-house and a transformer-house was carried on in 1907-08. The strip mill was put into operation in February, 1909, consisting of 14 passes, with a capacity of 50 tons per turn. Later, another finishing pass and alterations in the roll arrangement permitted rolling increased widths and raised the capacity to 80 tons per turn.

The construction of the portion of the works that was originally contemplated was not completed before additional construction was under way, the first of which was a cold-rolling department, consisting of 24 cold-rolling machines. This department started operation in July, 1909. About a month later a box-annealing furnace was put into operation, and this furnace, together with the necessary slitting and straightening and cutting machines, was the start of what now constitutes the largest department. About 1917 a galvanising department was added, and there has been almost constant expansion of Cuyahoga works until to-day.

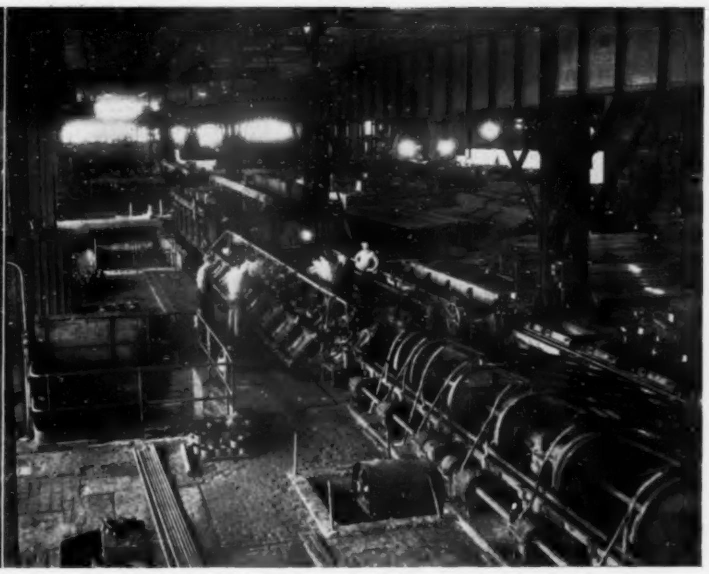
The billets and wide hot-rolled strip requirements at Cuyahoga are supplied by other subsidiary companies of the United States Steel Corporation. Products manufactured are round and shaped rods, hot-rolled strip, high- and low-carbon coarse round wire in bright, coppered and galvanised finishes; cold-rolled strip steel in high and low carbon; cold-rolled strip and drawn rounds of alloy steels and rustless steels in various finishes; single-loop, cross-head and miscellaneous bale ties; galvanised strand and guard-rail cable; also cold-rolled strip in bright, galvanised, lacquered and tinned finishes.

The first step of improvements to cold-rolling facilities was completed in 1931. Since this works was completed, the market for cold-rolled strip has experienced a revolutionary change. New equipment is being installed with higher rolling speeds, greater reductions, reduction of idle time of equipment, avoidance of rejections through better control of operations and through proper cleaning, annealing and handling, resulting in considerable savings in costs and a corresponding improvement in quality.

Capacity of Cuyahoga works is 165,000 tons of rods annually, 50,000 tons of hot-rolled strip, 105,000 tons of wire, and 120,000 tons of cold-rolled strip.

The Donora Steelworks, consisting of both blast furnaces and steelworks, was built in 1903-05 primarily to furnish 4 in. × 4 in. billets to Donora Wire Works. During recent years, however, billets have been furnished to other wire company's plants, and considerable tonnages of ingots, slabs and blooms to other constituent companies. In 1931 a continuous mill was installed which produces both 4 in. × 4 in. and 2 in. × 2 in. billets.

There are two blast furnaces, with the usual auxiliary equipment, at Donora Steelworks. They have a capacity of about 550 tons each per 24 hours. There is also a flue-dust sintering plant, installed in 1919, normally producing about 250 tons of sinter per day. There are 13 open-hearth



Charging hot metal into an open-hearth furnace and, right, part of one of the dimension tube mills, with set of reducing rolls in the foreground, at the works of the Pittsburgh Steel Company.

furnaces, with a rated capacity of 52,200 tons per month when using hot metal from the two blast furnaces. The furnaces are large enough to produce 100-ton heats. There are six rows of soaking pits, with four pits to a row, using natural gas fuel.

A steam-driven 40-in. mill normally supplies a $7\frac{1}{2}$ in. × $7\frac{1}{2}$ in. bloom to the continuous-billet mill, but can also produce slabs and blooms for shipment. The electrically-driven billet mill, installed in 1930, is so designed that a 4 in. × 4 in. billet can be taken out as an intermediary product or continued through all passes to produce a 2 in. × 2 in. billet. Capacity of the Donora Steelworks is 627,000 tons of ingots annually, 380,000 tons of pig iron, and 525,000 tons of billets.

Donora Wire Works occupies approximately the central portion of the Corporation properties at Donora, Pa. The plant was constructed between 1901 and 1903, and now comprises the original equipment with additions and extensions which were necessary to meet trade conditions during the past years. Originally, the plant manufactured common wire products, such as bright and galvanised wire, nails, barb wire, woven fencing and woven wire for concrete reinforcement. Such products are usually made from low-carbon basic or Bessemer steel. For the past few years the plant has produced less tonnage of these common products, and an increasing tonnage of special wire and wire products from high-carbon steel. Hot-rolled rods made to strict specifications as to uniformity of gauge, surface and other physical properties are now required by the manufacturing trade. Special heat-treated wires and increasing quantities of larger gauge wires are now produced. This change in manufacturing requirements has necessitated radical changes in manufacturing processes, and the equipment of the plant has had to be changed.

Two modern electrically-driven rod mills were completed, and started production in 1931. The plant is excellently situated, being near ample power and water resources, steel supply from the adjacent steelworks, and excellent transportation facilities, both by rail and water. Annual capacity is 320,000 tons of rods and 235,000 net tons of wire.

Donora Zinc Works, which ranks as one of the largest combined zinc and acid plants in the country, is located on property adjoining the Donora Wire Works. As constructed in 1915, these zinc works consisted of equipment for the storage of crude ore ; six units for roasting sulphide ore and the production of sulphuric acid ; 10 spelter furnaces with an ore-mixing department, and a pottery department for making the refractory retorts and condensers used in the furnace. In 1926 an extensive improvement programme was launched.

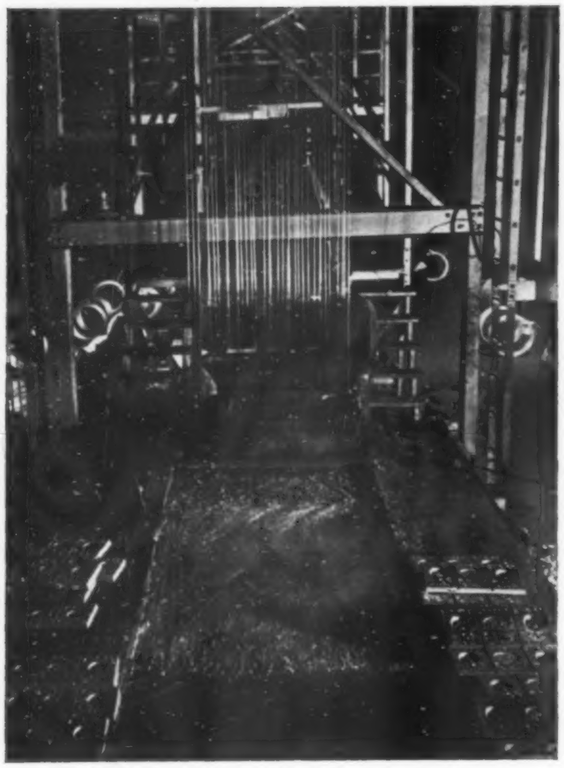
This programme saw the completion of ammonia-oxidation equipment, a plant for the sintering of roasted zinc ores, an oxide plant for the recovery of zinc from spelter-furnace residues, and masonry towers on three acid units replacing those of lead construction. In 1930 two modern 16-hearth roasting furnaces of the circular type were completed and placed in operation, replacing two of the original furnaces, together with facilities for the preparation of flotation ore in the crude ore department, also a precipitator for the collection of dust from the two sintering machines ; additions to this equipment in 1936 have doubled the capacity of the precipitator equipment. This dust is treated for the recovery of zinc, lead and cadmium in a plant employing the wet process, which also is equipped for the treatment of galvanising by-products.

The sulphuric acid equipment is comprised of six units, with a total designed capacity of 300 tons of 60° acid per 24 hours. By improved practices, however, the production was increased to 450 tons. In 1930 masonry towers replaced lead towers on No. 6 acid unit, which has resulted in a further increase in capacity for this unit. In 1935 similar improvements were made to the No. 4 and No. 5 acid units. Annual capacity of Donora Zinc Works is 70,000 tons of zinc and 165,000 tons of sulphuric acid.

LABORATORIES OF ALUMINUM CO. OF AMERICA

THE metallurgical research undertaken in the laboratories of the Aluminum Co. of America at Pittsburgh is devoted to the development of new and improved alloys and to new or improved processes for fabricating those alloys. Another basic study is that of the structural applications of aluminium. The metallurgical control of plant processes and products, together with any technical queries dealing with the company's products are handled by separate laboratories attached to each works.

It is often found that the work of the aluminium research laboratories yields valuable and unexpected by-products. A significant feature is that the laboratories do not always work with an eye on the immediate future, but prosecute research concerned with their materials or products for more distant application. One of the most important developments of these laboratories was the refinement by



Galvanising wire at the works of Pittsburgh Steel Company.

electrolytic means of aluminium of purity exceeding 99.95 per cent., and it will be appreciated that the provision of metal of this purity gave the welcome opportunity of studying, for the first time, the properties of the pure metal and of the alloys unaffected by those impurities which had been a factor in all previous work.

The laboratories have contributed papers on the equilibrium relations on the most important binary aluminium alloy systems. The results were correlated by the application of thermodynamic laws and so enabled a basis to be established for checking the accuracy of proposed phase diagrams and for establishing new data from minimum data. Work has also been done on ternary systems, and other papers have been produced as a result of data secured from new equipment used in the last few years. This equipment includes apparatus for checking electrical resistance at high temperatures, X-ray diffraction plant, and a precision dilatometer and interferometer which have been used to check portions of diagrams of questionable accuracy.

Much useful work is being done at the present moment in regard to the mechanism of age-hardening of aluminium alloys, and another type of fundamental metallurgical work which the laboratories have been doing is that related to the theories of corrosion. Recent tests show that corrosion of aluminium, at least in aqueous chloride solutions, is almost entirely due to electrochemical action. Consideration has been made of the potential relations and currents flowing between the different phases present in aluminium alloys, and between aluminium and other metals in contact with each other and an electrolyte. The electrochemistry of corrosion and the theory of cathodic polarisation will be the subjects of further papers.

Commercial alloys have been developed by this company from their investigations, and among those recently developed are such alloys as 4S, 24S, 52S, 53S, and 132. Alloy 4S was developed to give a strength intermediate between 2S and the heat-treated alloys; 24S is a very high-strength material used bare and in the form of Alclad sheet. 52S and 53S are alloys of moderate strength and with high resistance to corrosion, and are suitable for marine conditions. 132, or the alloy for Lo-Ex pistons, has low expansion and minimum growth characteristics.

The majority of American aeroplanes use unpainted Alclad 24S-T. The development of Alclad sheet by the Aluminium Research Laboratories has made a substantial contribution to the metallurgy of aluminium, and the principle of galvanic protection used in Alclad products has been extended in recent years.

Alloy 11S is often referred to as a duralumin type alloy, and has certain additions which give it free-cutting properties, promoting free machining in automatic screw-cutting machines. This free-machining property is the result of the formation of small chips which fall free of the tools and allow rates of production in automatic screw machines similar to those for free-cutting brass.

A well-laid-out and well-filled technical library should claim the admiration of visitors, as also should the test equipment, including rotating beam and constant deflection type fatigue machines, tension and cantilever specimens, and fatigue machines for making tests in repeated shear and rotating-beam tests at elevated temperatures, to mention but a few. Tests are carried out with a universal impact-testing machine to determine the ability of aluminium structures to withstand dynamic loads under conditions approximating to those in service.

PITTSBURGH STEEL COMPANY

THE Pittsburgh Steel Company, with plants in the Greater Pittsburgh steel manufacturing district, is an example of an independent company that has, during an era of large steel company mergers and consolidations, both maintained its independence and grown from a modest beginning to a successful firm of substantial size and importance in the lines which it manufactures.

The company was organised in 1901 as a manufacturer of finished wire products by a small group of steel and financial men. Important among these finished wire products were woven wire fences, barbed wire, wire nails, fence gates, and galvanised wire.

As the company grew and increased its fabrication of steel products it added rolling mills to roll its own steel, and in 1908 installed a battery of open-hearth steel furnaces for the manufacture of its own steel. In 1912-13 two large blast-furnaces were built, whereupon the company became an integrated manufacturer of its products from the iron ore to the finished products.

In 1903 was organised the Seamless Tube Company of America, a manufacturer of seamless steel tubes. Although this company was entirely separate from Pittsburgh Steel Company in its management, some of the same men were interested financially in the two companies, though they grew up side by side under separate financial structures. In 1909 the name of Seamless Tube Company of America was changed to Pittsburgh Steel Products Company, and in 1926 the financial interests that were concerned with both companies brought about their consolidation under a single management, since which time the combined business has been conducted under the corporate name of Pittsburgh Steel Company. Pittsburgh Steel Company to-day has properties valued at some 42 millions of dollars; a manufacturing capacity of approximately 800,000 tons of steel ingots and finishing mill capacity for manufacturing most of this production into finished wire and seamless tube products.

The visitor to the Monessen works of Pittsburgh Steel Company has the unique opportunity during a single brief visit of seeing the complete manufacture of steel through every process from the charging of iron ore, coke, limestone and other materials into blast furnaces to the completion of many finished wire products. In the nearby Allenport Works may also be seen the making of finished seamless

General view of coke ovens and blast furnaces at the Campbell, Ohio, plant of the Youngstown Sheet and Tube Company.

tube products from the seamless steel round ingots and round billets which come from the Monessen steel works.

The two huge blast-furnaces at the Monessen works have a combined capacity of 1,400 gross tons of molten iron per day. Into these furnaces correctly measured quantities of iron ore, limestone and coke are charged in an efficient manner from the adjoining bin and ore yard. The hot metal from the blast-furnaces is taken directly to the large hot-metal mixer, where it is kept ready for charging into the open-hearth furnaces.

Next in line of production are the 12 modern open-hearth furnaces, each with a capacity of approximately 125 tons of steel per heat, and all the necessary equipment for casting both square and round ingots by either the top-casting or bottom-casting methods.

When the somewhat cooled steel ingots are taken from the moulds, they are placed in the soaking pits and brought to a uniform predetermined temperature in preparation for the rolling mills. Next in line are the blooming mill and billet mill, where the steel is rolled and reduced to the cross-sections desired, representing customary sizes of blooms, billets, slabs and rounds. At this point the steel that is to be made into wire are billet sections either 4 in. × 4 in., $1\frac{3}{4}$ in. × $1\frac{3}{4}$ in., or $1\frac{1}{2}$ in. × $1\frac{1}{2}$ in.; these billets now go to the rod mills, where they are reheated and rolled to the desired rod size.

The numerous wire-finishing operations of the Monessen works cannot be discussed in detail here, but they include numerous modern wire-drawing blocks, a wide range of equipment from which wire in a range of sizes from $\frac{3}{4}$ in. to No. 34 gauge is drawn as required upon equipment that draws through one die, two dies, five dies, six dies, and up to 12 die-passes at a single operation; equipment for pot annealing, salt annealing, and lead annealing; special equipment for drawing coppered and lacquer-finished wire, stainless steel wire, and other special wires.

Other wire-finishing equipment and operations include wire galvanising processes and the manufacture of woven wire fences for farm, poultry, lawn and industrial enclosures; barbed wire, wire nails; bale ties and cold-rolled flat wire. A separate department also manufactures welded wire reinforcement for concrete roads, buildings, and other construction, and special wire lath for plaster, stucco floors, and for brick and stone veneer.

A short distance from Monessen are the company's Allenport works, which are devoted to the manufacture of seamless steel tubes exclusively. Here are reheating furnaces, piercing mills, rolling mills, sizing and straightening equipment, annealing furnaces, normalising furnaces, upsetting, bending, threading, hydrostatic testing and cold-drawing equipment, with which are manufactured finished seamless steel tubular products, such as oil-well casing, oil-well tubing, rotary drill pipe, boiler tubes, condenser tubes, heat exchanger tubes, high-pressure piping, refrigeration piping, cracking still tubes, refinery piping, and line-pipe.

Both the Monessen works and the Allenport works are located on the navigable Monongahela River, permitting the company to bring in many of its raw materials by water transportation and to ship many of its finished products by water transportation on the Monongahela, Ohio, and Mississippi Rivers to many points farther in the interior of the United States, and particularly to its pipe yards at Memphis, Tennessee, and Houston, Texas.

During the past three years an extensive modernising programme has been carried on throughout the Monessen works and Allenport works of the company, and the up-to-dateness and efficiency of the equipment is apparent to the visitor. The higher officials of the company at present include: Henry A. Rœmer, President; Alexander E. Walker, Executive Vice-President; Joseph A. Carter, Vice-President; Charles E. Beeson, Vice-President; Henry J. Miller, Vice-President; and John U. Anderson, Secretary and Treasurer.

Visits to Youngstown and Cleveland

On October 13 two parties will be formed, one for those interested in iron and steel works, and the other for those interested in non-ferrous works. The former group will spend a day at Youngstown and travel to Cleveland in the evening, while the non-ferrous group will travel direct to Cleveland, arriving in time for luncheon. The principal visits at Youngstown are the plant of Youngstown Sheet and Tube Co. and the plant of the Republic Steel Corporation. Additional visits to plants in this district include Cold Metal Process Co., Truscon Steel Co., Republic Steel Corporation at Niles, and Niles Rolling Mill Co.

The non-ferrous party have a choice of visits during the afternoon following their arrival in Cleveland. These include a visit to Cleveland Wire Works, where tungsten and molybdenum wire is manufactured; and to Nela Park, of the General Electric Co.

General view of Nos. 1 and 2 piercing mills at the seamless tube mill of Youngstown Sheet and Tube Company, Cleveland.

One of the large electric steel furnaces of the Canton Steel and Tube Division of the Timken Roller Bearing Company.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

THE Youngstown Sheet and Tube Company, with home offices at Youngstown, Ohio, has its principal plants located in the Mahoning River Valley, mid-way between Cleveland, Ohio and Pittsburgh, Pennsylvania, and in the Chicago, Illinois district. These plants have an estimated combined annual capacity of 3,000,000 gross tons of pig iron, and estimated combined annual capacity of 3,120,000 tons of steel ingots, and a capacity for finished steel which is approximately 2,200,000 tons yearly. The locations and descriptions of the various plants are as follows :

Campbell plant, located at Campbell, Struthers and Youngstown, Ohio : This plant, located on both sides of the Mahoning River, comprises approximately 354 acres of land. In this location are the following departments, after each of which is shown the estimated annual capacity : 306 by-product coke ovens—1,200,000 gross tons of coke ; a coke by-products recovery plant ; four blast-furnaces—1,058,400 gross tons of pig iron ; a pig-casting machne ; two Bessemer converters—480,000 gross tons of steel ingots ; 12 open-hearth furnaces—840,000 gross tons of steel ingots, and three hot-metal mixers.

There is equipment for the production of blooms, billets, slabs, plate, skelp, butt weld, lap weld and seamless pipe, hot- and cold-rolled sheets and strip, merchant bars, rods, wire, wire nails, wire hoops, conduit, metallic tubing and track spikes. These facilities include a blooming mill, a billet mill, a continuous skelp mill, five butt weld pipe mills, four-lap weld pipe mills, two seamless-tube mills, a pipe galvanising department, a coupling department, a 79-in. continuous hot-rolled strip mill, two continuous cold reducing mills, four automatic sheet mills, a sheet galvanising department, wire mill, wire hoop and barbed wire machines, a conduit department, and electrical metallic tubing department, and two track spike machines.

Indiana Harbour plant, located at East Chicago, Indiana : This plant is situated on Lake Michigan, at the mouth of the Indiana Harbour Ship Canal, and comprises approximately 289 acres of land. In this location are the following departments, after each of which is shown the estimated annual capacity ; 120 by-product coke-ovens—600,000 gross tons of coke ; a coke by-products recovery plant, two blast furnaces—561,600 gross tons of pig iron ; complete docks for the handling of ore and coal from lake boats ; a pig-casting machine ; two Bessemer converters—360,000 gross tons of steel ingots ; a hot metal mixer, and seven open-hearth furnaces—600,000 gross tons of steel ingots. There is equipment for the production of blooms, billets, slabs, sheet bars, plate, skelp, butt-weld and lap-weld pipe, merchant bars, rods, railroad-tie plates, tin plate, terne plate, and tin mill black plate. These facilities include a blooming mill, a continuous billet mill, a continuous sheet bar and skelp mill, two skelp mills, two butt-weld pipe mills, three lap-weld pipe mills, two merchant bar mills, 22 hot tin mills. two reversing cold-reduction mills, two temper pass mills, three railroad tie plate units, and a pipe galvanising department.

Brier Hill plant, located at Youngstown and Girard, Ohio : This plant comprises approximately 194 acres of land. In this location are the following departments, after each of which is shown the estimated annual capacity ; 84 by-product coke ovens—350,000 gross tons of coke : a coke by-products recovery plant ; two blast furnaces—464,400 gross tons of pig iron ; a pig-casting machine ; a hot metal mixer and 12 open-hearth furnaces—840,000 gross tons of steel ingots. There is equipment for the production of blooms, billets, slabs, rounds for seamless pipe, plate and electrically-welded pipe. These facilities include a blooming mill, two mills for rounds, one plate mill, and an electric-weld pipe mill. Stampings and pressed-steel products are manufactured at the Brier Hill Plant by the Youngstown Metal Products Company, a wholly-owned subsidiary.

South Chicago plant, located at South Chicago, Illinois : This plant comprises approximately 191 acres of land fronting on Lake Michigan. There are 70 by-product coke ovens with an estimated annual capacity of 420,000 gross tons of coke ; a coke by-products recovery plant ; three blast-furnaces with an estimated annual capacity for 602,400 gross tons of merchant pig-iron ; complete ore docks for the handling of ore and coal from lake boats ; a pig casting machine ; and other auxiliary facilities for the production of pig iron.

Evanston plant, located at Evanston, Illinois : This plant comprises approximately 12 acres of land on which are located two butt weld-pipe mills, a conduit department, a pipe-galvanizing department and equipment for the production of forged steel unions and water-well supplies.

Hubbard plant, located at Hubbard, Ohio : This plant comprises approximately 48 acres of land on which are located one blast-furnace with an estimated annual capacity of 160,000 gross tons of pig iron, a pig casting machine and other auxiliary equipment.

THE TIMKEN ROLLER-BEARING COMPANY

THE first units of the steel and tube division of the Timken Roller Bearing Company were made at the Canton plant about 1915. These consisted of a small tube mill and a furnace to reheat the round stock from which the tubes were made. Shortly after this it was decided to add melting equipment and electric furnaces were installed.

The plant grew steadily until at the present time the steel mill equipment includes three 100-ton open-hearth furnaces, one 100-ton electric furnace, one 50-ton electric furnace, two 25-ton electric furnaces, and one 10-ton electric furnace. The 100-ton is the world's largest electric furnace, and from this equipment is produced the world's largest tonnage of electric furnace steel. The open hearth as well as the electric furnaces are charged with two five-ton charging machines. The output from these furnaces is approximately 30,000 tons per month.

Other mill equipment includes a 35-in. three-high blooming mill, 28-in. three-high two-stand roughing mill, 22-in. mill, which is composed of three three-high and one two-high stands, and 16-, 12-, and 10-in. finishing mills. The seamless tube department includes piercing mills, reelers and sizing mills comprising units which give facilities for producing seamless tubes in a variety of sizes. Adequate furnace equipment is installed to reheat the rounds and tubes for further fabrication.

Furnaces for annealing and heat-treating bars, tubes or wire cover one entire section of the mill building. Some are fired with gas, while others are electrically heated, but all have the temperature controlled automatically.

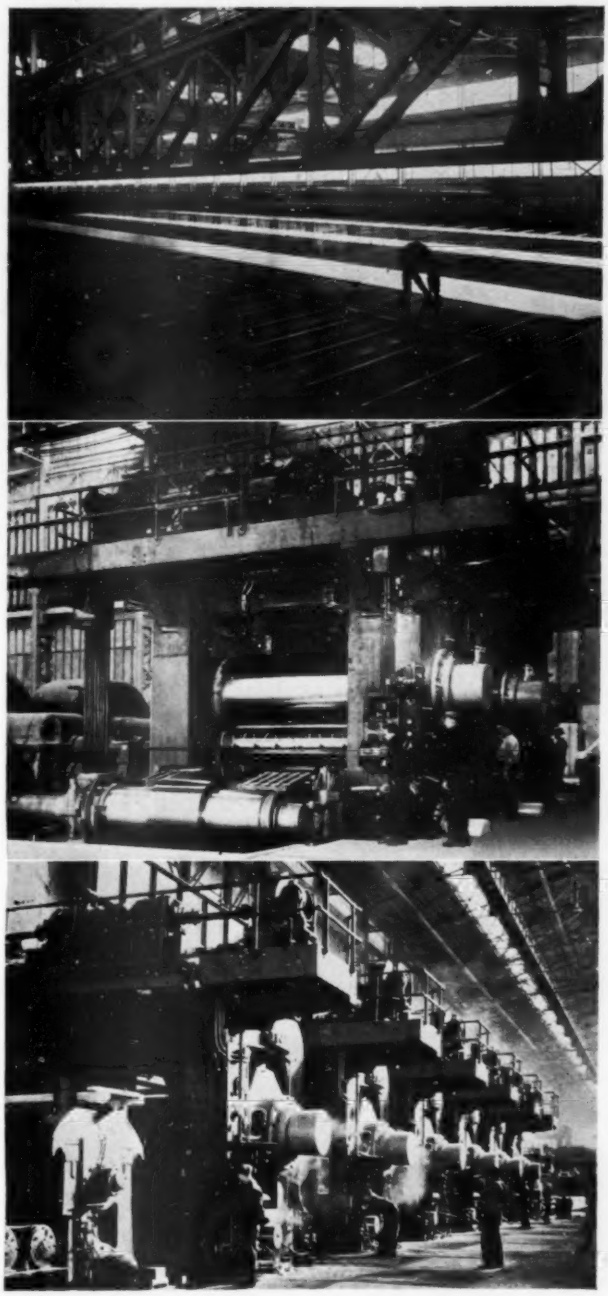
In addition to the plant at Canton, which is to be visited, another manufacturing unit for making steel is located in Wooster, Ohio, while another bearing factory is maintained at Columbus, Ohio, and a rock bit plant at Mount Vernon, Ohio. Associate companies for the manufacture of Timken bearings are located in this country and in France.

Cleveland

On the shore of Lake Erie, at the mouth of the Cuyahoga River, the town of Cleveland, Ohio, is 576 miles west of New York and 340 miles to the east of Chicago. Its clean layout will be apparent, as this is said to be the first American city to be planned with a civic centre and with important public buildings grouped around a mall, the latter taking in 104 acres. A deep ravine divides the city, through which the Cuyahoga makes its way to Lake Erie, a high-level bridge connecting Public Square on the east side with Detroit Avenue on the western side. This bridge and the Hillard road bridge over Rock River gorge are splendid examples of engineering. Euclid Avenue is the rapidly growing shopping and retail centre.

Architectural features include the Terminal group of buildings, with Terminal Tower rising to 708 ft., and of classic design; the 42nd floor is set apart for observation purposes by visitors. Here also are the Hotel Cleveland, the Medical Arts building, and the Builders' Exchange. The Union Trust building, Museum of Art, Municipal Market, the Arcade—a unique type of building—,the Museum of Natural History, and the Cleveland Symphony Orchestra Music Hall are other architectural features.

Along the lake front in the heart of the city are open grounds; the Gordon Park is five miles east, containing 113 acres of grass and woodlands, and six miles to the west is Edgwater Park, continuing for 6,000 ft. along the lake front. At the entrance to this park, and at the beginning of a boulevard system that leads from the high level bridge to the extreme western limit of the city, is Bulkley Boulevard. Other attractive parks are Shaker Lakes, Brookside Park, Woodland Hills Park, Rockefeller Park, and Monumental Park in the Public Square. From the industrial point of view we feel that it would be redundant to detail its many activities, but reference may be made to some of the works included in the visit, which are Timken Steel and Tube Division of Timken Roller Bearing Co.; the Canton, Massillon and Corrigan McKinney Divisions of Republic Steel Corporation; Chase Brass and Copper Co.; Cleveland Graphite Bronze Co.; Eaton Manufacturing Co.; and Lincoln Electric Co.



Some illustrations of the new continuous-strip mill of Republic Steel Corporation, Cleveland, Ohio.

Top.—Steel strip is gauged as it passes from the run-out table across this transfer table to the hot-mill finishing department. A truss, 30 ft. high and 216 ft. long, is provided above the transfer table to carry the weight of large travelling cranes which operate overhead on each side of it.

Centre.—The 98-in. three-stand tandem continuous cold-reduction mill.

Bottom.—View of the six finishing stands in operation. Each stand weighs 425 tons, is 22½ ft. wide and 29 ft. high above the base. From the last of these stands strip emerges at a speed up to 2,120 ft. per minute.

The Rouge plant of Ford Motor Company, with the administration building and the Rotunda in the foreground.

REPUBLIC STEEL CORPORATION

THE huge 98-in. hot- and cold-strip mills of Republic Steel Corp. once were erected on what was the bed of the Cuyahoga River, Cleveland, and have much of outstanding interest for visitors. The buildings cover some 21 acres and in them steel strip can be rolled at the rate of 2,120 feet per minute, or more than 24 m.p.h.

The 98-in. hot mill comprises ten massive stands in tandem, and the cold mill has three 98-in. stands, also in tandem, and two single 98-in. 3-stand mills for temper rolling and surface finishing. Modern pickling, annealing, shearing and finishing equipment are added, the mill producing large and small sheets, light plates and coiled strip for use in almost all industries.

From a slab storage yard fed by a new 48-in. blooming mill, magazine type depilers feed slabs weighing from 2½ to 9 tons each to three 80-ft. furnaces, each of which have the capacity to deal with 50 tons of steel an hour. The slabs leave the furnaces at a temperature of 2,250° F. and are taken by roller table to the hot mill where they pass through the scale breaker, and water, under 1,200 lb. per sq. in. pressure, is directed upon them. After passing through the first roughing stand, the slabs are pressed to correct width in a hydraulic squeezer, the thickness of the slabs being reduced to approximately ¾ in. by the roughing stands. They are then held on a 142-ft. delay table for cooling to suitable temperature for rolling in finishing stands, this being checked by electric pyrometer. The ten 98-in. stands for the hot mill weigh 425 tons each, are 22½ ft. wide and 29 ft. high above the base.

From the last of the finishing stands, of which there are six, the strip emerges at speeds up to 2,120 ft. per minute and travels down a run-out table, each roll of which is individually driven. This table is stated to be the largest ever built and is 603 ft. long.

Strip for cold rolling is taken from this run-out table and rolled through coilers before it is taken by conveyers to the pickling room, but strip which requires no further processing is moved slowly across the hot bed until it has cooled sufficiently for shearing to size.

Pickling is done by two continuous units of 505 ft. length, each consisting of four 6,000-gallon acid tanks and two 4,000-gallon water tanks; and annealing of cold-rolled strip is undertaken in five batteries of automatic furnaces. No less than 1,450 motors are installed, these ranging in size from ½ h.p. to 4,500 h.p., and requiring as much current as would supply a city with a population of 100,000.

The new mill makes available flat-rolled sheets of larger size, with consequently less cutting, fitting, welding or rivetting costs for fabrication. The provision of larger sheets means greater effect and greater economy in designing new products or in redesigning some existing products. A high degree of accuracy is claimed, to which end modern roll grinding equipment is installed and is well worth inspection.

The Republic concern make open-hearth steels and irons, including alloy and carbon steels; electric furnace steels, Bessemer and tool steels; pig iron, coke and by-products; stainless and heat-resisting steels; plates, pipes; bar mill products; rail steel bars and shapes; spikes; sheets for all purposes; strip; tin plate; wire and wire products; bolts and nuts; boiler and condenser tubes; steel window frames, bridge flooring, metal office furniture, bins, toolboxes, air-conditioning cabinets, boiler jackets, and a multitude of other steel fabricated products. Semi-finished steel can be supplied in blooms, billets or slabs, or sheet bars, skelp or wire rods.

Republic Steel Corp. is the title of a combination of five divisions: the Berger Manufacturing division, Niles Steel Products division, Union Drawn Steel division, Steel and Tubes Inc., and the Truscon Steel Company.

Detroit

Members and guests depart from Cleveland by special steamer on October 16, which is due to arrive at Detroit about 5 p.m. This famous automobile centre in Michigan is the county seat of Wayne County, and the fourth largest city in the United States. Situated on the north-west bank of the Detroit River, it is near Lake St. Clair, divided from Canada by the river. It is 272 miles from Chicago, 250 from Buffalo, 690 from New York City, and 170 miles from Cleveland, Ohio.

Detroit is laid out in severely mathematical plan, but relieved by a series of magnificent avenues from 100 ft. to 200 ft. wide. Jefferson Avenue extends along the river, Woodward Avenue runs in at right-angles and so divides the city in half. Possibly the chief of the streets that will impress visitors is the Grand Boulevard, 12 miles long and 150 ft. wide, which encircles the centre of the city from Belle Isle at the east to the river at 26th Street.

The original planning of the city can be seen in the layout of Campus Martius, an open space about 600 ft. by 200 ft., intended to be the centre of more or less concentric circles or arcs. The principal monuments are on or near the Campus, and close by are the City Hall, the Wayne County Courthouse, and the Majestic Building. The Public Library, Institute of Arts, the enormous General Motors building, and the Book Tower are but a few of the imposing buildings that are well worth a visit. There are no less than 51 public parks, with a combined area of 3,125 acres. Belle Isle is a pleasure resort on the Detroit River, made accessible by ferry service and a splendid bridge. Palmer Park, River Rouge Park (on the west side), and Clark Park and Goigt Park are good examples of open-space planning for health and pleasure.

Although perhaps best known as the centre of the American automobile industry, it should not be overlooked that Detroit has nearly 200 different industries in all, including aluminium goods, electrical machinery, hardware, foundry and machine-shop products and tinned foodstuffs. Particular interest will be attached to the visit to the River Rouge plant of Ford Motor Co., which will be made during

Tapping an open-hearth furnace at the steel mill of Ford Rouge plant.

Part of one of the engine machine shops at Ford Rouge plant, Dearborn, Michigan.

the morning and afternoon of October 17. Arrangements include three alternative groups during the morning comprising visits to the blast-furnaces, open-hearth furnaces and rolling mills ; the foundry and non-ferrous plants ; and a general visit to the plant, including assembly lines. The latter is planned for ladies only. During the afternoon members will visit the engine and car assembly lines, while the ladies visit Greenfield Village and the Edison Institute.

The autumn lecture of the Institute of Metals will be delivered at 8-30 p.m., in the Crystal Ballroom of the Book Cadillac Hotel ; the lecturer will be Dr. C. J. Smithells, and his subject " Gases and Metals."

Several visits to works in the Detroit district have been arranged for the following day. Thus in the morning members have a choice of seeing the works of Great Lakes Steel Corporation, Hoskins Manufacturing Co., or Revere Copper and Brass Co. ; or members and ladies may visit the National Metals Exposition. During the afternoon visits include Briggs Manufacturing Co., General Motors Research Laboratories, L. A. Young Spring and Wire Co., Ternstedt Manufacturing Co., Wolverine Tube Co., or the National Metals Exposition.

Additional visits to plants in Detroit may be made to Automatic Products Co., Bopp Steel Corporation, Detroit Seamless Steel Tube Co., Detroit Steel Corporation, Fisher Body Co., Stran-Steel Division of Great Lakes Steel Corporation, McLouth Steel Corporation, Rotary Electric Steel Co., and United States Rubber Co.

THE FORD MOTOR COMPANY

THIRTY-FIVE years ago, on June 16, 1903, there occurred in Detroit an event which was destined to play an important part in the subsequent development of the city. It was the organisation of the Ford Motor Company. At that time Old Detroit had a population of about 300,000 people. Horses and street cars were the accepted means of transportation, and very few people imagined that it would ever be otherwise. A few, however, were interested in the possibilities of a horseless carriage, and there were a number of small motor-car " factories " in the city. So it was no occasion for excitement when Henry Ford, who had already been building petrol-driven vehicles for a number of years, started to organise a new company.

True, it is, Henry Ford was well known in the city at that time. He had formerly been chief engineer of the Detroit Edison Company ; and he had built Detroit's first motor-car. Later, he had made racing cars which had won races in competition with the fastest creations that other engineers could offer. He had been interested in the Detroit Automobile Company.

It was slow work getting the new company started. John and Horace Dodge took a block of stock as compensation for using their little machine shop to build his motors. A carpenter, named Stredlow, took another block in exchange for a small shop at Mack Avenue, and the belt line tracks which Henry Ford planned to use for his assembly plant. Alex Malcolmson, a Detroit coal-dealer, invested $7,000, and Charles J. Woodall and James Cousens, two of Malcomson's employees, invested as much as they could raise. John F. Gray, a candy manufacturer, put in a substantial amount, and Anderson and Rackham, Ford's lawyers, put up $5,000 each. The Company was capitalised at $100,000, but only $28,000 in cash was actually paid into the treasury.

Henry Ford held 25½% of the original stock. In 1906 he acquired sufficient stock to bring his holding up to 51%. Later, he purchased an additional 7½%. In 1919 Edsel B. Ford, who succeeded his father as president, purchased the remaining 41½% of outstanding stock. On July 9, 1919, the Ford Motor Company was organised under the laws of Delaware with an authorised capitalisation of $100,000,000.

From the very beginning the Company grew steadily. Less than a month after its formation the Company shipped its first cars—three in number,—one to Indianapolis, another to Minneapolis, and another to St. Paul. The first year the Company sold 1,708 cars. Within four months after it was started it declared its first dividend, and began its plant expansion. That expansion has continued throughout the years until to-day Dearborn is the home of the world's largest single industrial development—the Rouge plant of the Ford Motor Company.

Here within the boundaries of a single plant are railroads, ships, machine shops, blast furnaces, glass plant, repair shops, steel plant, rolling mills, coke ovens, and numerous other industrial works, each of which elsewhere would be a sizable factory by itself.

The plant extends over 1,096 acres. Its present buildings have a floor space of more than 7,250,000 sq. ft., with other

enormous buildings going up under the current expansion programme. Within its boundaries are over 90 miles of railroad tracks. It contains the world's largest foundry, covering 30 acres. Its power comes from the largest industrial steam generating plant in the world. It normally uses in a single day more than 538,000,000 gals. of water—more than the cities of Detroit, Cincinnati and Washington combined. It has a mile and one-third of docks.

The Ford Motor Company built and sold more than 15,000,000 of its famous Model " T " between 1908 and 1927. From this programme its factories turned to the development of a new motor-car, the Model " A," of which more than 5,000,000 were built, before the operation was again altered to start production on the now-famous Ford V-8. In all, the Ford Motor Company has built and sold more than 26,000,000 motor-cars and vehicles !

In 1922 the Lincoln Motor Company was purchased by the Ford Company, which immediately inaugurated plans to build the finest car that modern automobile engineering could produce. To extend the benefits of these experiences in fine-car production, the Lincoln Motor Company in 1936 developed a car entirely new from the standpoint of construction and engineering. This new car, the Lincoln Zephyr, immediately won public favour in the medium-price field.

Besides smaller manufacturing plants in various parts of the country there are 12 other Ford plants in close proximity to Detroit—at Northville, Waterford, Milan, Phœnix, Plymouth, Saline, Nankin Mills, Newburg, Dundee, and one being built at Milford. Other plants are at Iron Mountain, Mich., St. Paul, Minn., Green Island, N.Y., Hamilton, Ohio, L'Anse, Mich., and Pequaming, Mich.

The Ford Company also owns and operates lake freighters and barges carrying ore, limestone, coal, sand and lumber from Great Lakes ports to the Rouge plant. Four especially designed canal boats carry material from the Rouge to the assembly plants at Chester, Pa., and Edgewater, N.J. Other Ford boats operate at sea, carrying automobile parts on the Atlantic and Pacific coasts and to foreign ports.

The Ford Company operates 16 assembly plants, 1 sales and 19 sales and parts branches throughout the United States. There are associated Ford Companies with manufacturing plants at Windsor, Canada ; Dagenham, England ; Strasbourg, France ; and Cologne, Germany. The plant at Windsor supervises sales and supplies material for Canada with seven branch organisations in Canada, and supplies practically all of the British Empire with the exception of the British Isles. Dagenham supplies the United Kingdom and certain material to European assembly organisations. Cologne manufactures parts for Germany, and has jurisdiction over Germany, Austria, Hungary and Czechoslovakia. The Ford Motor Company owns a major proportion of the share holdings of Ford Motor Company, Ltd., England, and Ford Motor Company A.G., Cologne, Germany.

In addition to the manufacturing plants there are assembly plants, service plants and offices, and associate companies located at : Buenos Aires, Argentine ; Cristobal, Canal Zone ; Havana, Cuba ; Mexico City, Mexico ; Montevideo, Uruguay ; Rio de Janeiro, Brazil ; Santiago, Chile ; San Paulo, Brazil ; Shanghai, China ; Yokohama, Japan ; Alexandria, Egypt ; Antwerp, Belgium ; Asnieres, France ; Barcelona, Spain ; Bologna, Italy ; Bucarest, Rumania ; Copenhagen, Denmark ; Cork, Ireland ; Helsingfors, Finland ; Istanbul, Turkey ; Lisbon, Portugal; Amsterdam, Holland ; Stockholm, Sweden ; and Athens, Greece.

It is noteworthy that a day has been devoted to the visit to the River Rouge plant, but even this time is much too short to enable visitors to see all the interesting features these works can show.

A DETROIT TUBE COMPANY

It is to be expected that a company which have specialised in the manufacture of tubing exclusively for more than 20 years will provide much of interest to members, and this is certainly true of the Wolverine Tube Co., of Detroit. This company were one of the first to import, and subsequently develop, the extrusion process in the United States, and make a speciality of seamless tubing for condensers, air-conditioning plant, evaporators, and allied applications such as in refrigeration work, automotive, oil-burner, and the plumbing industries. Tubing is made in aluminium, and in such alloys as Muntz metal, Admiralty, red brass ; and in 99.9% copper and 99·2% arsenical copper.

The company contend that the adoption of more critical methods of manufacture allow less expensive alloys to be used with entire satisfaction even in severe corrosion-creative conditions ; the two major factors being refinement of grain structure and stringent inspection at every stage of production. As first example, we may consider the Wolverine sequence of production for seamless condenser tubing.

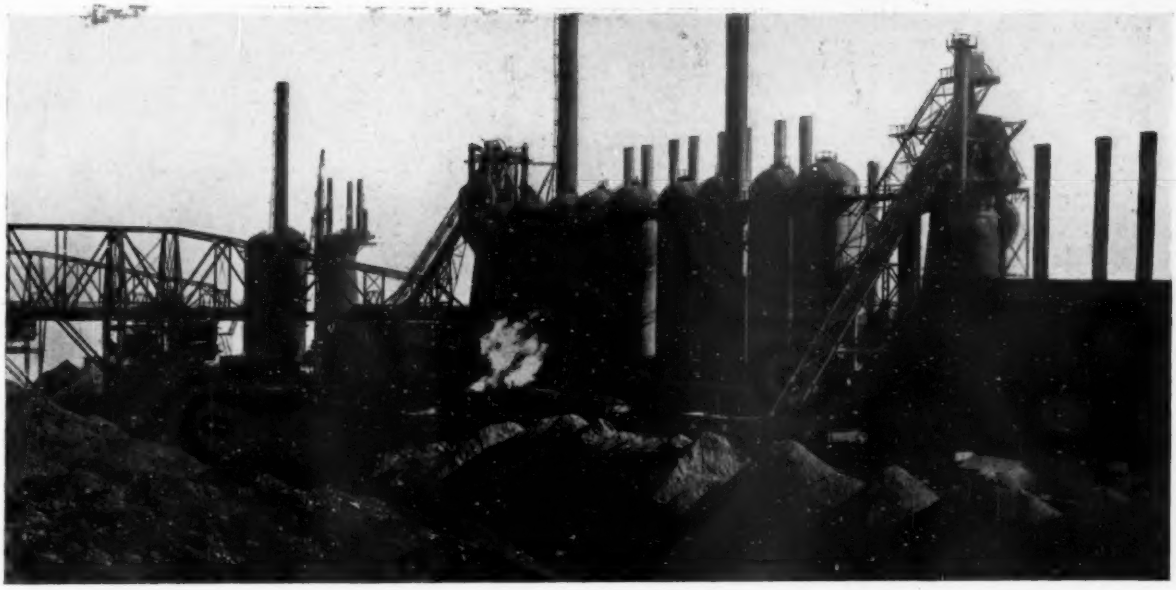
Strict metallurgical control is exercised in the casting shop where electric furnaces are used and the molten copper, of 99.9% purity, with its definite oxygen content, is retained in the furnace under a blanket of charcoal briquettes to prevent further oxygen absorption. Then, when pouring temperature is reached, deoxidation is obtained by the addition of a fixed weight of phosphor copper, so that the molten metal has approximately 0·02% phosphorus. It is then poured into water-cooled billet moulds. To ensure a clean, non-porous billet, water is allowed to drip into the mould during pouring, the water drip being at the rate of some 100 c.c. per min., and tending to draw the carbonised mould dressing to the centre and top of the rising column of metal, whilst also forming a blanket of steam above it, keeping oxidation to a minimum.

Each casting is cut by a low-speed circular saw into short billets, and very careful examination is made of the two end sections for casting flaws. But inspection goes much further than this. These short billets are next skimmed in a lathe and inspected for blow-holes or defects under the surface. This has the additional advantage that the billet makes a better fit in the extrusion container.

After inspection of the base-size tube produced by extrusion, it is then drawn down to correct finished size, but several intermediate annealings may be incorporated. After two or three passes through the drawing dies—for which one end of the tube is pointed and the other and opposite end is laced over a hollow rod that carries the draw-pin—the tube is annealed in continuous belt-type oil-fired furnaces, refining the grain structure to approximately 0.050 mm. at 75 diameters. Following pickling and pointing, drawing is continued until the tube is down to specified size or further annealing is required, this depending on the ultimate size demanded ; annealing generally following a reduction of around 90% in cross-section. The next process is bright annealing, and is carried out in a gas-fired General Electric Company furnace, a process which eliminates oxygen contact, but introduces sulphur and moisture which must subsequently be removed.

In manufacturing refrigerator tubing, electric annealing has been introduced. The new furnace eliminates the necessity for a water seal, and the product enters the furnace practically dry. Members will be interested in this furnace, which is a continuous unit of about 200 ft. in length, with accurate temperature maintenance for each zone. The conveyer speed can be regulated according to the degree of anneal required.

Another most interesting process is that developed for producing copper or aluminium tubing with integral



Exterior view of blast furnaces and hot-air stoves at the Indiana Harbour works of Inland Steel Company. Ore storage is shown in the foreground with conveyer bridge for carrying ore from boats and unloading dock.

finning. The tube of metal is passed between a set of rolls in which the three forming tools are a series of discs which form a helical groove in the solid metal, then exert side pressure on the grooves thus formed and swage them up into a narrow, continuous fin integral with the metal. Finned tubing with an external diameter of 1¼ in., and root diameter of ⅝ in., can be formed from tubing with an initial external diameter of ¾ in., the fins thus formed being 0·015 in. thick at the outer edge.

These finned tubes, of the size quoted as example, are produced at 2½ ft. per min., and all types can be coiled by the simple method of winding around the mandrel of a lathe. The tubing is bright annealed to dead soft before finning.

Section IV—Return to New York or Boston, with optional visits to Chicago or Buffalo

THIS section is provided with several alternatives, each terminating with the return voyage to Europe. The first is the direct return from Detroit to New York by night train for those who are returning by R.M.S. *Queen Mary*, due to sail at 4 p.m. on October 19. The second alternative provides arrangements extending to October 23, whereby members and guests return from Detroit to New York or Boston via Buffalo and Niagara Falls. and either join the S.S. *Laconia* at New York on October 22, or at Boston the following day, for the transatlantic crossing. The third alternative provides for a short stay at Chicago and return to New York or Boston, the sailing arrangements being the same as in the previous alternative. A longer stay in Chicago is arranged in the fourth alternative, the return to New York being planned so that members and guests sail on October 26 by the S.S. *Aquitania*.

During the week, October 17 to 21, the American Society for Metals is holding a Metals Week at Detroit, and members of the British Institutes are cordially invited to remain in Detroit for a longer period than that allowed in the programme to take part in the meetings which will be held. Opportunities to visit the National Metals Exposition and works in the district will also be provided. Attention is directed particularly to the invitation contained in the contribution to the Foreword in this issue by Professor G. B. Waterhouse, President of the American Society for Metals.

Detroit to New York via Buffalo and Niagara Falls

The parties travel by night train on October 18 from Detroit to Buffalo and the following day alternative visits to works are arranged. These include an all-day visit to the Lackawanna Plant of Bethlehem Steel Co.; the Donner Plant of Republic Steel Corporation; Bliss and Laughlin, Inc.; or the Research Laboratories of Union Carbide and Carbon Co.; Carborundum Co., or Titanium Alloy Manufacturing Co. On October 20 various visits are to be made in Niagara Falls, including the Ontario Hydro Power Co.; the International Nickel Co. of Canada, Ltd., at Port Colborne, and arrangements are made for further sightseeing near Niagara Falls. The party due to leave New York will travel on the night train from Niagara Falls, N.Y.

Visit to Chicago and return to New York or Boston

The party due to visit Chicago have alternative excursions arranged for them in Detroit during the morning of October 19. These include the Plymouth Plant of Chrysler Corporation and the National Metals Exposition. The party depart by train for Chicago during the afternoon. The following day visits include the Gary Works of Carnegie-Illinois Steel Corporation, where members will see the world's largest steel mill. These works have annual capacities of over 3,000,000 gross tons of pig iron, 4,716,000 gross tons of basic open-hearth, Bessemer, and electric steel ingots. Alternatively, members may visit the works of Columbia Tool Steel Co., where the furnaces for rolling mills and heat-treatment operations are fired exclusively by natural gas; the American Manganese Steel Co., or Fansteel Metallurgical Corporation, where the metallurgical processes involved in the production of pure tungsten, tantalum, columbium, and some sintered carbides will be inspected.

The excursions arranged for October 21 include a visit to the Union Stock Yards, or a sightseeing drive for members and ladies. Instead, members may visit the Acme Steel Co., the largest non-integrated producers of hot- and cold-rolled strip steel; or the Stewart Die Casting Co. The parties depart for New York or Boston during the afternoon of the same day.

Cold-strip mill at the Indiana works of Inland Steel Company, showing in the foreground a slitter, roller leveller and flying shears from left to right.

Alternative Arrangements at Chicago

An alternative arrangement extends the stay at Chicago to October 25, and the party taking this extension will have the opportunity to visit the Indiana Harbor Works of Inland Steel Co., where there is a fully integrated mill with ore docks, coke-oven plant, blast-furnaces, and basic open-hearth furnaces. This is an all-day excursion, but an alternative plan enables members to visit Federated Metals Co. at Whitney, to inspect a modern plant for the recovery of secondary metals; International Lead Co. at East Chicago; other alternatives include the tractor works of International Harvester Co., the Hawthorne plant of Western Electric Co., and the works of Crane Co., where valves, fittings, and enamelled ware are among the manufactures.

The following morning a party visit the chemical and physical laboratories of the University of Chicago. A sightseeing tour of Chicago is arranged for the afternoon. On October 24 an excursion to Milwaukee is arranged, where visits include A. O. Smith Corporation, producers of automobile frames automatically and on a large scale; Milcor Steel Co., sheet-metal manufacturers; or the whole day may be used to visit the works at Grand Crossing and South Chicago, Illinois, of Republic Steel Corporation. The train for New York leaves Chicago at 3-15 p.m. on October 25, and the party joins the S.S. *Aquitania* the following day for the transatlantic journey.

Chicago

This, the second city in the United States, lies on the south-west shore of Lake Michigan, in Cook County, in the State of Illinois. Its position gives it a water frontage of 24½ miles, the city extending some 10 miles inland. Its growth began in 1830 and real development was influenced by the opening of the Illinois and Michigan Canal in 1848, the development of railway facilities in 1849 and 1852, and to the application of steam to navigation which made passenger and freight transport across the lake comparatively easy, opening up communication between Buffalo and Chicago.

As is probably well known, the chief industry is meat packing, but other leading industries include steel works and rolling mills, foundry and machine-shop products, electrical machinery and supplies, printing, publishing, and clothing.

Chicago has become an important railway centre, with terminals for 23 through lines, including six electrified lines. No lines, however, pass through the city. Serious efforts to improve town planning have constantly been made, and to-day the park system forms a cordon round the central section of the city, from Lincoln Park in the north to Jackson Park on the south shore of the lake; the various parks being connected by a series of boulevards. Further civic planning is seen by the provision of 193 smaller parks, ranging from 10 to 75 acres.

The Chicago Public Library is one of the outstanding institutions of its kind in the United States, the main building is on Michigan Avenue, between Washington and Randolph Streets. The Merchandise Mart, Chicago Art Institute, Newberry Library, Field Museum of Natural History, and the Chicago Union Passenger Station, are other examples of this city's architecture which deserve attention. Most big American cities are very conscious of the necessity and advantages of education. Chicago is a good example, having several universities and institutes, with many fine buildings for them.

INLAND STEEL CO.

DESCRIBED as the largest independent producers of steel in the Central West, the Inland Steel Co. started a steel-producing plant on the shores of Lake Michigan, at Indiana Harbor, with an annual production of approximately 20,000 tons gross. This production is now one hundred times greater, the present steel-making capacity of 2,000,000 tons gross per year being attained in 1929.

American history and geographical considerations influenced the growth of the company. The Central West needed steel bars and small shapes for farm implements and domestic furnishings, and the newly incorporated Inland Steel Co. began to re-roll rails into bars and small shapes at Chicago Heights. This plant now has a capacity of 100,000 tons per year, fence posts being one production. From that beginning in 1893, and the establishment of the Indiana Harbor steel plant in 1902, the company grew rapidly, purchasing iron ore properties in Minnesota in 1906, and thus making certain of the supply of ore of uniformly high grade. Logically enough, the company constructed its first blast-furnace a year later, and incorporated a subsidiary company in 1911 to carry their raw materials to the furnaces. A further contribution to their need for self-sufficiency was made in 1913, when coke ovens and coke by-product plant was put down. By 1916 the company were prepared to supply one million tons gross per year, largely stimulated by war-time necessity, secured additional adjacent property, built many new furnaces and mills for rolling a wider diversity of products.

The growth of the American railways is a matter of history. The Inland Company started to roll rails in 1922,

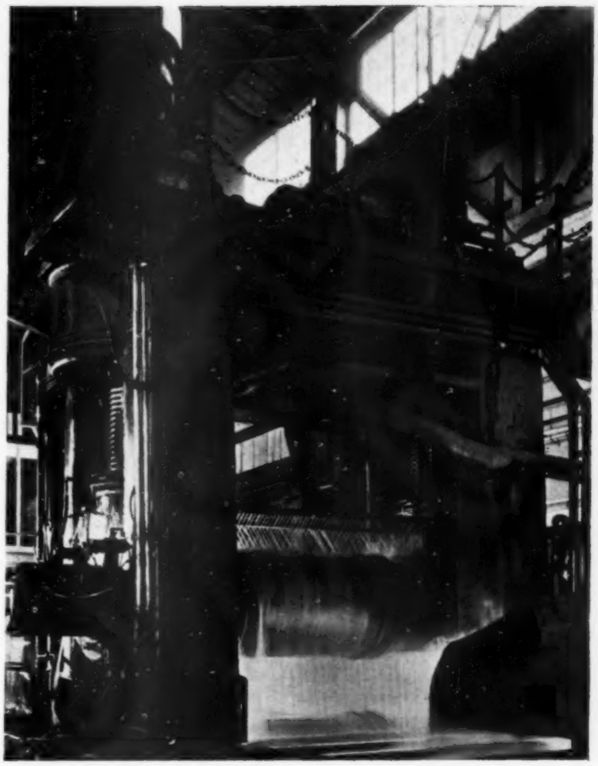
and now makes a very large volume of rails and track accessories; developing which policy they acquired the Milwaukee Rolling Mill Company's steel sheet rolling plant in 1924. During the next four years coal-mining had been added to the company's activities, and in 1928; properties at Manistique, Michigan, were purchased, to assure supply and control of limestone.

The present products of this company include blooms, billets, slabs, and sheet bars; structural shapes; plates; bar-mill products; sheet and strip steel, both hot- and cold-rolled; heavy T-rails; track accessories, such as spikes, bolts, angle splice bars and tie-plates; steel sheet piling; rivets; fence posts; a very complete range of rail steel in bars and shapes. Copper-alloy steel is made for all types of product, and the coke by-products comprise ammonium sulphate, benzole, toluol, solvent naphtha, and creosote oil.

The basic open-hearth steel products include copper-bearing steel sheets—the copper alloy can be specified for all rolled steel products at a slight additional cost,—a low alloy, high-strength steel marketed under the trade name of Inland Hi-Steel, with copper, nickel and phosphorus contents and consequent high degree of resistance to corrosion, a steel that can be cut, punched, formed, and worked hot or cold; and a lead-bearing steel known as Ledloy, that has fast machining properties. A small amount of lead is added to the open-hearth steel, and is stated to be dispersed uniformly in such fine state that it cannot be seen under the microscope, in which form it has no effect upon the physical properties of the steel except for slightly reduced grain size, but considerably increases the speed at which it can be machined, together with additional economy due to extension of tool life.

This steel is produced in all hot-rolled forms, and is finished by cold-drawing concerns; its advantages apply to all rolled shapes on which extensive machining operations are required.

The company have 27 open-hearth furnaces, with capacities up to nearly 200 tons per melt each. A 76-in. continuous strip mill was installed in 1932, and has a rated capacity of 50,000 tons a month, designed for rolling plates $\frac{3}{16}$ in. to $\frac{3}{4}$ in. thick up to 72 in. wide, and strip 0·042 in. × 18-36 in., up to 0·076 in. × $74\frac{1}{2}$ in. The tonnage is essentially low carbon steel, with some manganese steels also being rolled. Actually, tonnages in excess of 70,000 per month have been rolled. Slabs are supplied from a 46 in. blooming mill in line with the strip mill, and having a 46-in. × 104 in. slabbing stand driven by a 7,000 h.p. motor, and served by nine circular soaking pits, each pit being fired with 14 combination oil and coke-oven gas burners, and either fuel may be used as desired.



A 46-in. blooming mill which supplies slabs for the 76-in. and 44-in. continuous mills at the Indiana Harbor plant of Inland Steel Company. The illustration shows a heavy ingot being rolled into slab form.

There are three continuous heating furnaces of the triple-fired type, fired with fuel oil, and each with a rated capacity of 50 tons per hour. The first roughing mill is of the broadside type, a four-high stand of the universal type, 49 in. and 36 in. × 95 in., and slabs up to 87–90 in. in length may be cross-rolled on this stand. The three remaining roughing stands are also four-high, and the finishing stands consist of six four-high mills, 49 in. × $24\frac{1}{2}$ in. × 77 in. Finishing temperatures of the strip range from 1,350°–1,700° F., depending on the composition and gauge of the strip.

Cold-rolling equipment is very complete, consisting of five five-stand tandem mills, four 54-in. tandem mills, three 72-in. tandems, four planish mills for tin-plate, skin mills for sheet gauges, and four two-high mills, two of the latter being located in the run-out building of the hot mill, one 30 in. × 80 in., and the other 29 in. × 73 in.

View of finishing end of pickling department at Indiana works of Inland Steel Company, where material is oiled before being coiled. Conveyer in foreground delivers coils to cold-strip mill.

Niagara Falls (Ont.) and Chicago to Boston

Those including Boston in their programme are due to arrive at 9 a.m. on October 21 from Niagara Falls (Ont.), and the morning will be occupied in sightseeing. During the afternoon both members and ladies visit the Massachusetts Institute of Technology. The party from Chicago arrive in Boston the following day, and both parties visit the Harvard University or occupy the afternoon in sight-seeing. These join the S.S. *Laconia* on October 23, whichis due to sail from Boston at 4-30 p.m.

Boston

Most English-speaking peoples will regard Boston as particularly rich in history, a town that had intimate relationship with this country.

To-day it is a busy and important harbour, carrying a large part of America's import trade, is served by passenger and freight lines to the chief ports of Europe, and with other lines to the Far East, South America, and Australia. It lies at the head of Massachusetts Bay and comprises the major portion of Suffolk County, and is encircled by hills.

Washington Street, which is the main thoroughfare of the city, must be one of the narrowest of the business streets of America, but most of the modern streets are laid out on the rectangular plan and are as straight as the nature of the land allows. The harbour is nearly land-locked, and is only 6½ miles from the open sea, with a main ship channel giving a depth of 35 ft. at low tide. The Great Commonwealth Pier at South Boston is 1,200 ft. long and 400 ft. wide, and can accommodate five ocean-going vessels each of 600 ft. length.

Twelve bridges span the Charles River between Boston and its northern shore, the granite-built Longfellow Bridge being of unusual type, based upon a Russian original. Foundry work, machine-shop products, electrical plant and equipment are included in its several industries. Historic and ancient buildings are to be expected in this city. Among such are the Old South Meeting House—an 18th century church on the corner of Washington and Milk Streets, and which has the spire characteristic of New England churches,—the Old State House, which is believed to be the oldest public building now existing in America, Faneuil Hall and Market, and the Quincy Market. The State capitol of Massachusetts, built in 1795-1798, is a prominent feature, on the summit of Beacon Hill. Various additions have been made, and this is now flanked by two big wings of white marble at right-angles to the original building.

New British Chemical Standards

FERRO-VANADIUM NO. 205 AND NI-CR-MO STEEL "B."

Bureau of Analysed Samples, Ltd., announce the following analytically standardised samples, which are now ready for issue :—

FERRO-VANADIUM, NO. 205.	%
Vanadium	52·2
(Carbon	0·16)
(Silicon	1·18)
(Sulphur	0·03)
(Phosphorus	0·05)

Figures in brackets not standardised.

NI-CR-MO STEEL "B."	%
Carbon	0·35
Silicon	0·25
Sulphur	0·034
Phosphorus	0·024
Manganese	0·61
Nickel	3·05
Chromium	0·68
Molybdenum	0·34

The Ferro-Vanadium is a typical sample of the type of alloy appearing on the British market. It is also useful to chemists for the purpose of adding exact amounts of vanadium to standard steels to bring the vanadium to the required percentage for testing out methods of analysis.

The Ni-Cr-Mo steel has a composition similar to one of the typical specifications for this class of material.

As usual, each standard has been analysed by a number of chemists representing independent analysts and chemists representing well-known manufacturers and users.

Each purchaser will be provided with a certificate showing the analysis of each chemist and giving an outline of the methods he has used. In particular, modern methods for V, Cr, and Mo will be of special interest.

The standards are issued in bottles containing 25 g, 50 g., 100 g., and 500 g., at prices estimated to cover the cost of production.

The standards may be obtained direct from Bureau of Analysed Samples, Ltd., 3, Wilson Street, Middlesbrough, or through the usual laboratory furnishers.

Andrew Carnegie Research Fund

The Council of the Iron and Steel Institute are prepared to make annually a limited number of grants from the Research Fund founded by the late Mr. Andrew Carnegie in aid of metallurgical research work.

The object of the scheme is not to facilitate ordinary collegiate studies, but to enable students, who have passed through a college curriculum or have been trained in industrial establishments, to conduct researches on problems of practical and scientific importance relating to the metallurgy of iron and steel and allied subjects. Candidates, who must be under 35 years of age, must apply before September 30, on a special form to be obtained from the Secretary of the Institute.

The value of the grant will depend on the nature of the proposed research work, but the maximum amount granted in any one year will, as a rule, not exceed £100. The grant will be divided into four instalments. Of these, the first will be paid on or about January 1, and the second and third on our about July 1 and October 1, subject to the receipt of adequate progress reports. The final instalment will not be paid until a complete report on the entire research, in a form suitable for publication, has been received ; this should be submitted not later than the following May 31 (in exceptional cases, an extension of an additional year may be granted).

The Council may, at their discretion, award a further grant in aid of any particular research work, which seems to them sufficiently meritorious to justify further assistance.

The results of the research shall be communicated to the Iron and Steel Institute, which will have the right of priority of publication in full, and will bear the whole costs thereof ; subject to the approval of the Council, they will be printed in the "Carnegie Scholarship Memoirs," a volume of which is published in December of each year. Papers of particular interest may be selected for discussion at general or additional meetings of the Iron and Steel Institute.

In considering the allocation of grants, the Council cannot undertake to accept any particular proposal, but will be guided by the nature of the subjects proposed for investigation, giving preference to those which, in their judgment, appear to be of the most practical advantage to the iron and steel and allied industries.

Monel Data Book.—1

MUCH of the matter previously published on the uses of Monel, nickel, and Inconel has now been collated and produced in the form of a data book. In this the properties and applications of these three metals are described, a useful feature being the inclusion of tables and working instructions.

Following a short section on the origin of Monel is a very useful section giving its physical and mechanical properties, corrosion resistance in acids, alkali solutions, and in atmospheres. The properties and forms and the fabrication of malleable nickel and Inconel are also given. The main body of the data book gives the resistance of all three metals to specific corrosive agents ; a 14-page chapter tabulates their uses in the process industries—this being decidedly well detailed,—and their applications in a variety of industries, including textile, pickling equipment, food manufacturing equipment, laundries, hospitals, motor boats, aircraft ; Monel-covered plywood, power plant, and accessories, also notes on the use of Monel electrodes for welding cast iron.

Copies can be obtained from Henry Wiggin and Co., Ltd., Thames House, Millbank, London, S.W. 1.

Shells from Loco Works

A substantial part of the works of the North British Locomotive Co. Ltd., has been devoted to care and maintenance for some time now, and we hear that shell making machinery which is being installed will enable one of the best of the factory workshops at the company's Atlas Works, Springburn, Glasgow, to be brought into use for munition manufacture.

Reviews of Current Literature

Chemishe Analysen-Methoden für Aluminium und Seine Legierungen

(Methods of chemical analysis for Aluminium and its alloys.)

A SECOND edition of this brochure follows a year after the first. The brochure is in unabashed " cookery book " style with no discussion of principles. This, of course, is not required by the practising analyst, provided he can have confidence in the methods given. The authority under which this book is issued, the central body of the government-controlled aluminium industry of Germany (at present the largest consuming country for aluminium) disposes of doubts as to the reliability of the methods set forth. The experienced analyst will have no difficulty in forming his own opinions of the utility of the methods given.

The purpose of the brochure, as set forth in the preface, is to assist users of aluminium in Germany in obtaining rapid and unexceptionable analyses of their materials. The field covered is restricted to the common constituents of aluminium and its alloys.

The arrangement of the book is such as to be of great convenience to the practising analyst. Each method is printed on one side of a single large page, which is perforated so that it may be torn out if desired and placed on the work table. If the pages are not torn, they will remain protected for a long time by the stout board binding, and will lie flat. Each method is set out very clearly in paragraphs covering title, principles of the determining reaction (given only as briefly annotated chemical equations), limitations of application, reagents and apparatus required, method of procedure (all single steps included), sources of error, accuracy obtained, and time required. To set the matter out thus compactly, so that it may have complete usefulness requires the utmost in terseness and absolute excision of non-essentials. This has been achieved.

One comment is that the methods might be even more readily followed were each step set out on a separate line, or at any rate separated from each other by a dash or wide space ; the same applies to the description of the reagents and apparatus where their expeditious assembly might perhaps be increased still further by a similar layout of the text. The extra space required might be obtainable at the expense of headings and margins.

Nineteen analyses are described, comprising :—

Silicon—4 methods.
1. Standard acid gravimetric (Otis-Handy).
2. Standard soda gravimetric (Regelsberger).
3. Oxyquinoline volumetric for high values.
4. Molybdate colourimetric for low values.

Iron—4 methods.
1. Direct permanganate volumetric.
2. Titanous chloride check volumetric.
3. Aluminium-reduction permanganate volumetric for copper alloys, etc.
4. Thiocyanate volumetric for low values.

Copper—2 methods.
1. Electrolytic.
2. Ferrocyanide colourimetric for low values.

Titanium—2 methods.
1. Peroxide colourimetric.
2. Volumetric against ferric chloride.

Magnesium—2 methods.
1. Oxyquinoline volumetric.
2. Phosphate gravimetric.

Manganese—3 methods.
1. Bismuthate volumetric or colourimetric.
2. Chlorate volumetric.
3. Manganous oxide volumetric.

Antimony—1 method.
1. Sulphide colourimetric, not suitable for alloys containing copper, tin, lead, etc.

Zinc—1 method.
1. Electrolytic.

The times given are all agreeably short—a big advantage in works practice. It is probable that some experience would be required to achieve the speeds of work estimated, but the authors claim that these are capable of being improved upon if the work is well organised.

The brief paragraphs on sources of error are enlightening and are rounded off by notes as to how the errors are countered in the methods. The descriptions of the methods, though brief, are commendably precise and no doubt is left of the concentrations and temperatures at all stages ; a big help to consistency and accuracy.

This book obviously is not a text-book suitable for students, but advanced chemistry students specialising in aluminium as well as those engaged in the commercial analysis of the metal would find it of great utility.

Edited by Dr. K. STEINHÄUSER and issued by the Chemical Committee of the Aluminium-Zentrale. (Published by Verlag Aluminium-Zentrale, Literarisches Büro, Berlin. In German. Price, inland RM 3, abroad RM 5.)

Effect of Impurities in Copper

THE scope of these investigations into the effects of impurities in copper is given in full in this Research Monograph. When the Association was formed 18 years ago its Research No. 1 was devoted to the effect of impurities on the properties of copper, this investigation being carried out at the National Physical Laboratory over a period of several years. The effects of various elements and combinations of such elements were reviewed, and some twenty reports were published. This publication summarises and reviews the whole of the work in the light of the latest knowledge, and incorporates the final conclusions reached, if, indeed, any conclusions can be regarded as final in the scientific and metallurgical world.

The methods of preparation and testing of the materials used are detailed, and this is followed by a short chapter on commercially pure copper. The major portion of the book presents a detailed discussion of the effects of various impurities, including oxygen, hydrogen and oxygen together, sulphur, iron, phosphorus, silicon, bismuth, and lead ; arsenic, antimony, nickel, and silver individually and in various combinations ; the combined effect of nickel, antimony, and oxygen ; and of bismuth, arsenic, antimony, nickel and oxygen, considering these as two or more together.

Examination was made by tensile, impact, hardness, fatigue and bend tests, and physical tests included density and electrical conductivity measurements. A very useful discussion on the segregation of impurities follows, and the authors conclude with a chapter in which the comparative effects of the various impurities are summarised.

Value is enhanced by the inclusion of ample photomicrographs, diagrams, summary charts and tables, and a decidedly practical feature is the provision of an index so arranged that the effects of any given impurity, combination or group of impurities, can easily be ascertained.

By S. L. ARCHBUTT and W. E. PRYTHERCH. Published by British Non-Ferrous Metals Research Association, Regnart Buildings, Euston Street, London, N.W. 1. 12s. 6d. net, postage 6d.

Aluminium

In our review of the above work by Douglas B. Hobbs, published in the August issue, we gave only the address of the publishers, the Bruce Publishing Co., Milwaukee, U.S.A. We are advised that this useful book can be purchased from B. T. Batsford, Ltd., 15, N. Audley Street, Grosvenor Square, Mayfair, London, W. 1 ; price 15s.

Business Notes and News

New Offices of Aluminium Union Ltd.

Will readers kindly note Aluminium Union Ltd. are removing from their present offices at Bush House, to new offices at the Adelphi, Strand, W.C. 2, to which all future correspondence should be directed. Their new telephone number is Temple Bar 7766.

Extensions of Reynolds Tube Co.

To cope with the heavy demands being made for their materials Reynolds Tube Company Limited announce further large scale extensions to their already large plant for the production of light alloy tubes and sections. These include a 5,600-ton extrusion press, the largest in the world, together with a further 2,750-ton press. The large press will produce sections weighing ¾ ton and up to 60 ft. in length, in heat-treatable high-strength alloys. Work is well advanced, and the new units are expected to be in operation by the end of this year.

These new additions will make Messrs. Reynolds works the largest in the country, devoted solely to the production of light alloy sections and tubes.

Iron and Steel Works Closed

The state of the iron market and the accumulation of scrap is given as the reason for the closing of Ulverston Ironworks, Lancs., and the stoppage of two furnaces which have been in operation for sixteen months.

Stoppages involving 150 men have been made as a result of shortage of orders at the Appleby-Frodingham steelworks, Scunthorpe, and the steel furnaces of the Frodingham plant have not been operating since August 1. The rolling mill and the melting shop have also been closed. On the other hand, the Appleby plant continues operation and work on the extension is going ahead, whilst the steelworks of Richard Thomas and Co., and of Firth and Brown are operating normally.

Admiralty Contracts

A contract for four special motor torpedo boats has been placed with the British Power Boat Company, also two experimental boats. In addition to experimental boats, three flotillas of six boats each has been authorised, and the Admiralty has placed a number of orders for these boats, capable of over 40 knots, during the last three years.

Four motor torpedo boats have been ordered from Messrs. Vosper and Co. Ltd., and Messrs. J. I. Thornycroft and Co. Ltd., have received a contract for two such boats.

Three of the Dido class cruisers of 5,450 tons displacement in the 1938 programme are to be built in northern shipyards. Subject to settlement of certain points, the Admiralty have decided to contract for the construction of one of these cruisers with each of the following companies : Messrs. Cammell Laird and Co. Ltd., Birkenhead ; Messrs. Scotts' Shipbuilding and Engineering Co. Ltd., of Greenock ; and Messrs. R. and W. Hawthorn, Leslie and Co. Ltd., Hebburn-on-Tyne. The Dido class was authorised in 1936, construction of the first five was begun in 1937 and two others were included in that year's programme. All will be completed in 1939.

Lead and Zinc Output Control

There would be a number of difficulties in the path of those who propose some form of control for output of lead and zinc. The copper agreement, for instance, was a very different matter as there are only about half a dozen important non-U.S. copper producers, and some of them had close ties ; but any lead agreement would have to involve the Canadian producers, those in Australia, Jugoslavia, Mexico and possibly Burma, still leaving much tonnage outside the scope of the discussions. The Mexican producers, with a 12% export duty already imposed, and conscious of their relation to their Government and labour interests, would certainly find difficulties to overcome, but it does appear that the position of the mining companies would be improved by some form of restriction. The price of zinc is less than the cost of production but lead is still in excess of production cost ; but it must be remembered that the production of lead in the non-U.S. producing groups is estimated at from 10,000 to 15,000 tons a month greater than present consumption, and there is nothing to indicate that demand is improving or that output is being reduced. Some form of restriction scheme might well have a beneficial effect on zinc as well.

Road-Rail Containers

To expedite the manufacture of road-rail containers, and the repair of railway freight vehicles, the L.M.S. is developing the wagon works at Bromsgrove, Worcs., and at Earlestown, Lancs. The addition of new plant at the latter factory will make it possible to complete one container in two working days. The importance of this development is shown by the fact that this railway company already possess more than 8,340 such containers.

Iron and Steel Position

The production of steel ingots and castings showed a definite decline in Sheffield and North Lincolnshire in July, partly accounted for by the holiday period when some 30,000 workers in the steel and allied industries were given a week's holiday with pay. The decrease of 29·6% in Sheffield for July should not be considered alone, as the seven months' aggregate of 945,400 tons is only 4·2% less than the aggregate for the corresponding period of 1937.

There has been an improvement on the North-East coast in regard to the volume of inquiries handled recently, making it appear that the depressed conditions may not continue. Iron and steel producers are of the opinion that a recovery, even though small, of business will be experienced during the autumn. Producers held heavy stocks of pig-iron, but these are beginning to decline, rather slowly it is admitted, and possibly no further restrictions will be needed. Accumulations of East Coast hematite are no longer growing, and increased demand would create a welcome reduction of the tonnage remaining at producers' works. In addition, Cleveland qualities are out of production and there is not much foreign foundry iron now remaining in consumers' plant, so that stocks should decrease steadily from now on.

Home and export business is small but inquiry for heavy finished steel shows some improvement, a useful tonnage of structural steel is being taken regularly, and the lighter sections of the trade are experiencing comparatively quiet conditions. With steel prices stabilised to the end of the year, there may possibly be no revision of heavy scrap steel quotations for the last quarter of this year.

The developments at Ebbw Vale, and elsewhere, have created problems which the Executive Council of the Iron and Steel Confederation have asked the Government to call a conference and consider. The letter sent to the Prime Minister recently, conveyed this resolution : " This Executive Council directs the attention of the Government to the grave social and economic consequences of intensive mechanical and technological development now proceeding in certain branches of the iron and steel industry. These threaten to lay derelict certain tinplate and steel sheet producing districts in Monmouthshire and South Wales. The Council urges the Government to convene a conference of representatives of the employers' associations in the sections of the industry affected, the trade unions whose members are involved, and the Government, with a view to formulating plans for the purpose of avoiding the worst consequences of such development in districts already suffering from severe unemployment."

MARKET PRICES

ALUMINIUM.

98/99% Purity		£100	0	0

ANTIMONY.

English	£70	10	0
Chinese	49	0	0
Crude	35	0	0

BRASS.

Solid Drawn Tubes	lb.	0	0	11½
Brazed Tubes	,,	0	1	1½
Rods Drawn	,,	0	0	9¼
Wire	,,	0	0	8¾
*Extruded Brass Bars	,,	0	0	4¾

COPPER.

Standard Cash		£41	0	0
Electrolytic		46	10	0
Best Selected		46	5	0
Tough		45	15	0
Sheets		76	0	0
Wire Bars		47	10	0
Ingot Bars		47	10	0
Solid Drawn Tubes	lb.	0	1	0½
Brazed Tubes	,,	0	1	0½

FERRO ALLOYS.

‡Tungsten Metal° Powder. nominal	lb.	£0	4	9½
‡Ferro Tungsten° nominal	,,	0	4	8
Ferro Molybdenum°				
Ferro Chrome, 60-70% Chr. Basis 60% Chr. 2-ton lots or up.				
NOMINAL: 2–4% Carbon, scale 12/- per unit	ton	34	15	0
NOMINAL: 4–6% Carbon, scale 8/- per unit	,,	24	5	0
NOMINAL: 6–8% Carbon, scale 7/6 per unit	,,	24	0	0
NOMINAL: 8–10% Carbon, scale 7/6 per unit	,,	24	0	0
§Ferro Chrome, Specially Refined, broken in small pieces for Crucible Steelwork. Quantities of 1 ton or over. Basis 60% Ch. Guar. max. 2% Carbon, scale 12/6 per unit	,,	37	0	0
Guar. max. 1% Carbon. scale 13/- per unit	,,	39	0	0
§Guar. max. 0.5% Carbon, scale 13/- per unit	,,	49	0	0
‡Manganese Metal 97–98% Mn	lb.	0	1	3
‡Metallic Chromium	,,	0	2	5
§Ferro-Vanadium 25–50%	,,	0	14	0
§Spiegel, 18–20%	ton	11	0	0
Ferro Silicon—				
Basis 10%, scale 3/- per unit nominal	ton	10	5	0
20/30% basis 25%, scale 3/6 per unit	,,	12	0	0
45/50% basis 45%, scale 5/- per unit	,,	12	10	0
70/80% basis 75%, scale 7/- per unit	,,	17	0	0
90/95% basis 90%, scale 10/- per unit	,,	30	0	0
§Silico Manganese 65/75% Mn., basis 65% Mn.	,,	18	15	0
§Ferro-Carbon Titanium, 15/18% Ti	lb.	0	0	4½
Ferro Phosphorus, 20–25%	ton	22	0	0
§Ferro-Molybdenum, Molyte	lb.	0	4	9
§Calcium Molybdate	,,	0	4	5

FUELS.

Foundry Coke—				
S. Wales	—	2	0	0
Scotland	—	1	15	0
Durham	—	1	14	6
Furnace Coke—				
Scotland		1	10	0
S. Wales	—	1	9	0
Durham	—	1	7	6

GUN METAL.

*Admiralty Gunmetal Ingots (88 : 10 : 2)		£63	0	0
*Commercial Ingots		46	0	0
*Gunmetal Bars, Tank brand, 1 in. dia. and upwards	lb.	0	0	11
*Cored Bars	,,	0	1	1

MANUFACTURED IRON.

Scotland—			
Crown Bars	£13	10	0
N.E. Coast—			
Rivets	12	15	0
Best Bars	15	15	0
Common Bars	12	10	0
Lancashire—			
Crown Bars	13	10	0
Hoops	14	2	6
Midlands—			
Crown Bars	13	10	0
Marked Bars	15	15	0
Unmarked Bars		—	
Nut and Bolt Bars	11	15	0
Gas Strip	14	2	6
S. Yorks.—			
Best Bars	15	15	0
Hoops	14	2	6

PHOSPHOR BRONZE.

*Bars, "Tank" brand, 1 in. dia. and upwards—Solid	lb.	£0	0	11
*Cored Bars	,,	0	1	1
†Strip	,,	0	0	11
†Sheet to 10 W.G.	,,	0	0	11½
†Wire	,,	0	1	1
†Rods	,,	0	1	1
†Tubes	,,	0	1	6½
†Castings	,,	0	1	3

†10% Phos. Cop. £33 above B.S.
†15% Phos. Cop. £38 above B.S.
†Phos. Tin (5%) £32 above English Ingots.

PIG IRON.

Scotland—			
Hæmatite M/Nos.	£6	13	0
Foundry No. 1	6	0	6
,, No. 3	5	18	0
N.E. Coast—			
Hæmatite No. 1	6	13	0
Foundry No. 1	5	11	6
,, No. 3	5	9	0
,, No. 4	5	8	0
Silicon Iron		—	
Forge	5	8	0
Midlands—			
N. Staffs. Forge No. 4	5	8	0
,, Foundry No. 3	5	11	0
Northants—			
Foundry No. 1	5	11	6
Forge No. 4	5	5	6
Foundry No. 3	5	8	6
Derbyshire Forge	5	10	0
,, Foundry No. 1	5	14	0
,, Foundry No. 3	5	11	0
West Coast Hæmatite	7	4	8
East ,, ,,	7	3	6

SWEDISH CHARCOAL IRON AND STEEL.

Export pig-iron, maximum percentage of sulphur 0·015, of phosphorus 0·025.	
Per English ton	Kr.195
Billets, single welded, over 0·45 Carbon.	
Per metric ton	Kr.335-385
Per English ton	£17 11 3/£20 3 9
Wire Rods, over 0·45 Carbon.	
Per metric ton	Kr.375-405
Per English ton	£19 12 2/£21 4 9
Rolled Martin Iron, basis price.	
Per metric ton	Kr.230-250
Per English ton	£12 1 2/£13 2 2
Rolled charcoal iron, finished bars, basis price.	
Per metric ton	Kr.360
Per English ton	£18 17 6

f.o.b. Gothenburg.

SCRAP METAL.

Copper, Clean	£33	10	0
,, Braziery	30	0	0
,, Wire		—	
Brass	23	0	0
Gun Metal	33	0	0
Zinc	8	0	0
Aluminium Cuttings	71	0	0
Lead	13	10	0
Heavy Steel—			
S. Wales	3	10	0
Scotland	3	6	0
Cleveland	3	7	0
Cast Iron—			
Midlands	3	5	0
S. Wales	3	10	0
Cleveland	3	15	0
Steel Turnings—			
Cleveland	2	12	6
Midlands	2	5	0
Cast Iron Borings—			
Cleveland		—	
Scotland	2	2	6

SPELTER.

G.O.B. Official		—	
Hard	£8	10	0
English	14	7	6
India	12	0	0
Re-melted	10	0	0

STEEL.

Ship, Bridge, and Tank Plates.			
Scotland	£11	10	0
North-East Coast	11	10	0
Midlands	11	10	0
Boiler Plates (Land) Scotland	12	0	0
,, ,, (Marine) ,,		—	
,, ,, (Land), N.E.Coast	12	0	0
,, ,, (Marine) ,,		—	
Angles, Scotland	11	0	6
,, North-East Coast	11	0	6
,, Midlands	11	0	6
Joists	11	6	0
Heavy Rails	10	2	6
Fishplates	14	2	6
Light Rails	10	7	6
Sheffield—			
Siemens Acid Billets	11	15	0
Hard Basic .. £6 17 6 to	10	2	6
Medium Basic, £6 12 6 and	10	0	0
Soft Basic	8	15	0
Hoops	11	15	0
Manchester			
Hoops	11	5	0
Scotland, Sheets 24 B.G.	15	15	0

¶ HIGH-SPEED TOOL STEEL.

Finished Bars 14% Tungsten	lb.	£0	3	0
Finished Bars 18% Tungsten	,,	0	3	10
Extras :				
Round and Squares, ½ in. to ¼ in.	,,	0	0	3
Under ¼ in. to $\frac{3}{16}$ in.	,,	0	1	0
Round and Squares, 3 in.	,,	0	0	4
Flats under 1 in. × ¾ in.	,,	0	0	3
,, ,, ½ in. × ¼ in.	,,	0	1	0

TIN.

Standard Cash	£190	15	0
English	191	0	0
Australian		—	
Eastern	197	2	0
Tin Plates I.C. 20 × 14 box	1	0	3

ZINC.

English Sheets	£28	0	0
Rods	18	0	0
Battery Plates		—	
Boiler Plates		—	

LEAD.

Soft Foreign	£14	13	9
English	16	15	0

* McKechnie Brothers, Ltd., Sept. 12. † C. Clifford & Son, Ltd., Sept. 12. ‡ Murex Limited, Sept. 12

Subject to Market fluctuations. Buyers are advised to send inquiries for current prices when about to place order.

§ Prices ex warehouse, Sept. 12. ¶ The prices fluctuate with the price of Tungsten.

METALLURGIA. *Contents.* For SEPTEMBER, 1938.

ADVERTISERS' ANALYSIS

Acids
Imperial Chemical Industries, Ltd., Imperial Chemical House, London, S.W. 1.

Alloys
J. H. Clifton, London.
Electric Furnace Products Co., Ltd., Norway.

Aluminium and its Alloys
Aluminium Union, Ltd., Bush House, London, W.C. 2.
British Aluminium Co., Ltd., King William St., London, E.C. 4.
L. Cameron, & Sons, Ltd., Sheffield.
Darwins, Ltd., Sheffield.
Electric Furnace Products Co., Ltd., Norway.
High Duty Alloys, Ltd., Trading Estate, Slough.
Wm. Mills, Ltd., Birmingham.
Northern Aluminium Co., Ltd., Bush House, London, W.C. 2.
Perry Barr Metal Co., Ltd., Birmingham.
Rudge Littley Ltd., West Bromwich.

Anti-Friction Metals
McKechnie Bros., Ltd., Rotton Park St., Birmingham.

Brass and Bronze
Clifford, Chas. and Son, Ltd., Birmingham.
I.C.I. Metals Ltd., Birmingham.
John Holroyd, Ltd., Rochdale.
Manganese Bronze & Brass Co., Ltd., Handford Works, Ipswich.
McKechnie Bros., Ltd., Rotton Park St., Birmingham.

Casehardening Compounds
Amalgams Co., Ltd., Attercliffe Rd., Sheffield.
G.W.B. Electric Furnaces, Ltd., Belgrave House, Belgrave St., W.C. 1.
I.C.I. Cassel Cyanide.
Kasenit Ltd., Holyrood St., Bermondsey St., London, S.E. 1.

Castings (Iron)
Rudge Littley Ltd., West Bromwich.
Wallwork, H., and Co., Ltd., Roger St., Manchester.

Castings (Non-ferrous)
Magnesium Castings and Products, Ltd., Slough.
Manganese Bronze & Brass Co. Ltd., Handford Works, Ipswich.
William Mills, Limited, Grove St., Birmingham.
Mond Nickel Co., Ltd., Thames House, Millbank, London, S.W. 1.
Northern Aluminium Co. Ltd., Bush House, Aldwych, London, W.C. 2.
Sterling Metals Ltd., Coventry.

Coke-Oven Plant
Gibbon Bros., Ltd., Albert Rd., Middlesbrough.
Woodall Duckham, Vertical Retort & Oven Construction Co., (1920), Ltd.

Crucibles
Morgan Crucible Co. Ltd., Battersea Church Rd., London, S.W. 11.

Electrodes
British Acheson Electrodes, Ltd., Sheffield.

Extruded Sections
McKechnie Bros., Ltd., Rotton Park St., Birmingham.
Northern Aluminium Co., Ltd., London.

Extruded Rods and Sections
McKechnie Bros., Ltd., Rotton Park St., Birmingham.
Northern Aluminium Co., Ltd., London.

Fluxes
Foundry Services Ltd., 285, Long Acre, Nechells, Birmingham.
Imperial Chemical Industries Ltd., Dept. C. 6, Imperial Chemical House, London, S.W. 1.

Forgings
Northern Aluminium Co., Ltd., London.

Foundry Preparations
Foundry Services Ltd., 285, Long Acre, Nechells, Birmingham.
Imperial Chemical Industries Ltd., Dept. C.6, Imperial Chemical House, London, S.W. 1.
J. W. Jackman & Co., Ltd., Vulcan Works, Blackfriars Rd., Manchester.
Thos. Wilkinson & Co., Ltd., Middlesbrough.

Furnaces (Electric)
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Demag Electrostahl, Germany.
Electric Furnace Co., Ltd., 17, Victoria St., London, S.W. 1.
General Electric Co., Ltd., Magnet House, Kingsway, W.C. 2.
G. W. B. Electric Furnaces, Ltd., Belgrave House, Belgrave St., London, W.C. 1.
Integra Co., Ltd., The, 183, Broad St., Birmingham.
Kasenit Ltd., Holyrood St., Bermondsey St., London, S.E. 1.
Metalectric Furnaces Ltd., Cornwall Rd., Smethwick, Birmingham.
Morgan Crucible Co. Ltd., Battersea Church Road, London, S.W. 11.
Siemens Schuckert, Ltd., New Bridge Street, London.
Wild-Barfield Electric Furnaces, Ltd., Elecfurn Works, North Rd., London, N. 7.

Furnaces (Fuel)
Brayshaw Furnaces Ltd., Manchester.
British Furnaces Ltd., Chesterfield.
Burdon Furnace Co., 136, West Princes St., Glasgow.
Cassel Cyanide Co., Ltd., Room 170F2, Imperial Chemical House, London, S.W. 1.
Dowson and Mason Gas Plant Co., Ltd., Levenshulme, Manchester.

Furnaces (Fuel)
Gibbons Brothers, Ltd., Dudley, Worcestershire.
Incandescent Heat Co., Cornwall Rd., Smethwick, Birmingham.
James Howden & Co. Ltd., 195, Scotland St., Glasgow, Scotland
Kasenit Ltd., Holyrood St., Bermondsey St., London, S.E. 1.
King, Taudevin & Gregson, Ltd., Sheffield.
Ofag Ofenbau, Düsseldorf, Germany.
Priest Furnaces Ltd., Albert Road, Middlesbrough.
Fused Blocks
Imperial Chemical Industries Ltd., Dept. C.6, Imperial Chemical House, London, S.W. 1.
Gas
British Commercial Gas Association, Gas Industry House, 1, Grosvenor Place, London, S.W. 1.
Gears
Wallwork, Henry, and Co., Ltd., Red Bank, Manchester.
Shorter Process Co., Ltd., Savile St. East, Sheffield.
Gun Metal Ingots and Rods
McKechnie Bros., Ltd., Rotton Park St., Birmingham.
Hardening Metals
Shorter Process Co. Ltd., Savile St. East, Sheffield.
I.C.I. Cassel Cyanide.
Heating Plants
Nu-way Heating Plants, Macdonald St., Birmingham.
Ingots (Non-Ferrous)
McKechnie Bros., Ltd., Rotton Park St., Birmingham.
Ironfounders.
Joshua Bigwood & Son, Ltd., Wolverhampton.
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Magnesium Castings, Ltd., Slough.
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Electromagnets, Ltd., 48, High St., Erdington, Birmingham.
Motors (Electric)
Metropolitan-Vickers, Ltd., Trafford Park, Manchester.
Naval Brass Ingots
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Non-Ferrous Metals
Birmetals, Ltd.
Reynolds Tube Co., Tyseley, Birmingham.
I.C.I. Metals Ltd., Kynoch Works, Witton, Birmingham, 6.
McKechnie Bros. Ltd., Rotton Park St., Birmingham.
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Oil Engines
Mirrlees Bickerton & Day, Ltd., Stockport.
Pig Iron
Barrow Hæmatite Steel Co., Ltd., Barrow-in-Furness.
Bradley & Foster, Ltd., Darlaston.
Presses
Eumuco Ltd., Beverley Works, Willow Ave., Barnes, London, S.W. 13.
Schloemann, A.-G., Düsseldorf, Germany.
Protection of Metal Parts for Use at High Temperatures
Calorizing Corporation of Great Britain, Ltd., 32, Farringdon St., London, E.C. 4.
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Rolling Mills
Agents in Great Britain: J. Rolland and Co., 2, Victoria St., London, S.W. 1.
Lamberton and Co., Coatbridge.
Maschinenfabric Froriep, Rheydt, Germany.
Rheinische Walzmachinenfabrik, Germany.
Robertson, W. H. A., and Co., Ltd., Bedford.
August Schmitz, A.-G., Germany.
Karl., Fr. Ungerer., Germany.
Silver Solder
Chas. Harrold & Co. Ltd., 283, St. Paul's Square, Birmingham.
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Barrow Hæmatite Steel Co., Ltd., Barrow-in-Furness.
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Daniel Doncaster & Sons, Ltd., Sheffield.
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United Steel Companies, Ltd., Sheffield.
Steel Sections
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Steel Tubes and Sections
Reynolds Tube Co., Tyseley, Birmingham.
Steelworks Plant
Wellman Smith Owen Engineering Corporation, Ltd., Victoria Station House, London, S.W. 1.
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Honeywell Brown, Ltd., 70, St. Thomas St., London, S.E. 1.
Integra Co., Ltd., 183, Broad St., Birmingham, 15.
George Kent, Ltd., Luton.
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Howden, T. C., and Co., 517, Fleet Street, Birmingham.
Tube Drawing Plant
Sundwiger Eisenhütte, Sundwig, Germany.
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Victor X-Ray Corporation Ltd., London and Chicago.

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